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NEW YORK STATE MUSEUM

63d ANNUAL REPORT

1909

In 4 volumes

VOLUME 2

APPENDIXES 2-4

TRANSMITTED TO THE LEGISLATURE FEBRUARY 21, 1910

ALBANY
UNIVERSITY OF THE STATE OF NEW YORK
1911

STATE OF NEW YORK

No. 45

IN ASSEMBLY

FEBRUARY 21, 1910

63d ANNUAL REPORT

OF THE

NEW YORK STATE MUSEUM

VOLUME 2

To the Legislature of the State of New York

We have the honor to submit herewith, pursuant to law, as the 63d Annual Report of the New York State Museum, the report of the Director, including the reports of the State Geologist and State Paleontologist, and the reports of the State Entomologist and the State Botanist, with appendixes.

ST CLAIR MCKELWAY
Vice Chancellor of the University

ANDREW S. DRAPER
Commissioner of Education

Appendix 2

Economic geology

Museum Bulletins 142, 143

Education Department Bulletin

Published fortnightly by the University of the State of New York

Entered as second-class matter June 24, 1908, at the Post Office at Albany, N. Y., under the act of July 16, 1894

No. 476 ALBANY, N. Y. AUGUST 1, 1910

New York State Museum

JOHN M. CLARKE, Director

Museum Bulletin 142

THE MINING AND QUARRY INDUSTRY OF NEW YORK STATE

REPORT OF OPERATIONS AND PRODUCTION DURING 1909

BY

D. H. NEWLAND

New York State Education Department
Science Division, May 17, 1910

Hon. Andrew S. Draper LL.D.
Commissioner of Education

SIR: I beg to communicate herewith and recommend for publication as heretofore, in the form of a bulletin of the State Museum, the accompanying report on the *Mining and Quarry Industry of the State of New York* for the calendar year 1909, prepared by David H. Newland, Assistant State Geologist.

Very respectfully
JOHN M. CLARKE
Director

State of New York
Education Department
COMMISSIONER'S ROOM

Approved for publication this 19th day of May 1910

A. S. Draper

Commissioner of Education

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REPORT OF OPERATIONS AND PRODUCTION DURING 1909

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D. H. NEWLAND

PREFACE

The present report follows the general plan of the preceding issues which have been compiled each year since 1904, its aim being to furnish a timely record of progress in the various mineral industries represented in New York State. The statistics of production, as well as much of the information relating to new discoveries and other matters of interest, have been supplied by the individual enterprises engaged in the exploitation of the local resources, and it is desired to express grateful acknowledgment for their cooperation.

INTRODUCTION

The mining and quarry enterprises of the State felt the stimulus of the improved business conditions last year and made good progress toward recovery from the depression that followed the 1907 panic. The value of the mineral production, as calculated from reports rendered by the individual enterprises, amounted in all to

$34,914,034, a gain of more than $5,000,000 over the total for 1908. The upturn was not sufficient to establish a new record for the industries, but it reflected their strong position and capacity for continued growth.

The valuation, it should be noted, has been based, so far as practicable, on crude materials, and though serviceable for comparing the course of the related industries from year to year it affords only a small measure of the contribution made by the general class of mineral activities that are represented in the State. The metallurgical and chemical products of mineral nature are among the largest items of local manufactures. The inclusion of pig iron alone in the list of products for last year would nearly have doubled the above total.

Among the notable features of the record for 1909 was a large gain in the product of iron ore which reached an aggregate of 991,008 long tons valued at $3,179,358. This represented a gain in quantity of nearly 300,000 tons over the total for the preceding year. The production fell a little short of the output in 1907, but with that exception was the largest reported for any year since 1891. The iron market during the early months was still under the influence of the depression and it was not until the spring season had well advanced that the mines began operations at full capacity. There were 12 companies who reported a production, against 10 in 1908 and 13 in 1907. The Adirondacks furnished the greater part of the increase, though the mines along the Clinton belt showed a substantial gain.

The various materials of clay constituted the largest items in the year's record, with an aggregate value of $12,351,482, as compared with $8,918,863 in 1908. The increase of nearly 40 per cent in the value of the production was due principally to the revival of the building trades and consequent demand for structural materials. The combined output of brick, tile, fire-proofing and terra cotta used for building purposes was valued at $9,342,015, against $6,071,850 in 1908. In 1907 these materials represented a value of $8,909,392. The number of building brick made last year was 1,518,023,000 of which 1,218,784,000, or about three fourths, consisted of common brick from the Hudson river region. The value of the pottery manufactures showed a smaller relative gain with a total of $1,827,193 as compared with $1,653,241 in 1908. The number of plants that were engaged in clay manufacturing of all kinds was 232 or 10 less than in 1908.

The quarries of the State contributed material valued at $7,061,580, against $6,615,614 in the preceding year. The total was divided according to the various uses into: building stone, $873,651; monumental stone, $138,313; curb and flagstone, $800,620; crushed stone, $3,214,374; other uses $2,034,622. The output of slate, millstones and limestone used in making hydraulic cement is not included in these totals. All kinds of stone, except marble, participated in the increased activity, but limestone and trap furnished most of the gain due to their extending application in road building. Important as the quarry industries are, they still fall considerably short of supplying the local requirements in building and ornamental stones.

The hydraulic cement industries reported a product valued at $2,122,902, a little less than in 1908 when the valuation was given as $2,254,758. A decreased output was reported by the natural rock plants, the total amounting to 549,364 barrels against 623,588 barrels in 1908. That industry has shown a steady decline for a number of years past. The manufacture of portland cement, on the other hand, gained slightly with a product of 2,061,019 barrels against 1,988,874 barrels in the preceding year. A considerable increase in the production of this material may be expected for the current year.

From the salt mines and wells there was obtained a total of 9,880,618 barrels of salt valued at $2,298,652. The production was the largest in the history of the salt industry and represented an increase of nearly 10 per cent over the total for 1908 which was 9,005,311 barrels valued at $2,136,736. The gain was distributed between the output of rock and brine salt, both classes showing about the same proportionate increase. Onondaga county for the first time failed to return the largest production and was outranked by Livingston county which has been the center of the rock salt industry. Within the last 25 years the State has increased its output by over 400 per cent.

The mines and quarries of gypsum reported an output of 378,232 short tons, which was also the largest ever recorded in New York State. The gain over the total of 318,046 short tons for 1908 amounted to nearly 20 per cent. The value of the different gypsum materials, including plaster of paris, wall plaster, and gypsum sold in unburned condition was $907,601 against $760,759 in the preceding year. The important developments in the western counties have been chiefly responsible for the expansion of the industry which has increased nearly tenfold in the last decade.

Petroleum and natural gas were reported last year at a value of \$2,960,356, against a value of \$3,059,308 in 1908. There was little change in the production of petroleum which amounted to 1,160,402 barrels as compared with 1,160,128 barrels in the preceding year, but a marked decline in prices was responsible for a large reduction in valuation. The flow of natural gas was approximately 3,825,-215,000 cubic feet and was valued at \$1,045,693.

The talc mines of the State made an output of 65,000 short tons valued at \$617,500, or a little less than in 1908 when the production was 70,739 short tons valued at \$697,390. The tálc, as heretofore, came from the Gouverneur district of St Lawrence county, which practically enjoys a natural monopoly of the fibrous talc consumed in paper manufacture.

The garnet mines in the Adirondacks were more active last year and reported an output of 3802 short tons valued at \$119,190 against 2480 short tons valued at \$79,890 in 1908. Conditions in the abrasive trade were considerably depressed, otherwise a larger gain would have been registered.

A production of 2,342,000 pounds of crystalline graphite valued at \$140,140 was made by the Adirondack mines. In 1908 the output was 1,932,000 pounds valued at \$116,100.

The mineral springs of the State reported sales of 9,019,490 gallons valued at \$857,342, as compared with 8,007,092 gallons valued at \$877,648 in 1908.

The miscellaneous mineral materials, including apatite, carbon dioxid, clay, diatomaceous earth, emery, feldspar, marl, millstones, metallic paint, slate pigment, pyrite, quartz, slate, sand and sand-lime brick, that were produced in 1909, amounted in value to \$2,170,-881. The value of the same materials in the preceding year was \$1,904,472.

Mineral production of New York in 1905

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	2 117 822	$2 046 864
Natural rock cement	Barrels	2 257 698	1 590 689
Building brick	Thousands	1 512 157	10 054 597
Pottery			1 620 558
Other clay products			2 603 861
Crude clay	Short tons	6 766	16 616
Emery	Short tons	1 475	12 452
Feldspar and quartz	Long tons	17 000	48 500
Garnet	Short tons	2 700	94 500
Glass sand	Short tons	9 850	7 765
Graphite	Pounds	3 897 616	142 948
Gypsum	Short tons	191 860	551 193
Iron ore	Long tons	827 049	2 576 123
Millstones			22 944
Metallic paint	Short tons	6 059	70 090
Slate pigment	Short tons	2 929	22 668
Mineral waters	Gallons	8 000 000	1 000 000
Natural gas	1000 cubic feet	2 639 130	607 000
Petroleum	Barrels	949 511	1 566 931
Pyrite	Long tons	10 100	40 465
Salt	Barrels	8 575 649	2 303 067
Roofing slate	Squares	16 460	94 009
Slate manufactures			1 000
Granite			253 955
Limestone			2 411 456
Marble			774 557
Sandstone			2 043 960
Trap			623 219
Talc	Short tons	67 000	469 000
Other materials[a]			1 800 000
Total value			$35 470 987

[a] Includes apatite, carbon dioxid, diatomaceous earth, fullers earth, marl, sand and sand-lime brick. The value is partly estimated.

Mineral production of New York in 1906

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	2 423 374	$2 766 488
Natural rock cement	Barrels	1 691 565	1 184 211
Building brick	Thousands	1 600 059	9 688 289
Pottery	....	....	1 795 008
Other clay products	....	....	2 472 003
Crude clay	Short tons	5 477	9 125
Emery	Short tons	1 307	13 870
Feldspar and quartz	Long tons	13 660	44 350
Garnet	Short tons	4 729	159 298
Glass sand	Short tons	9 000	8 600
Graphite	Pounds	2 811 582	96 084
Gypsum	Short tons	262 486	699 455
Iron ore	Long tons	905 367	3 393 609
Millstones	....	....	22 442
Metallic paint	Short tons	2 714	29 140
Slate pigment	Short tons	2 045	15 960
Mineral waters	Gallons	8 000 000	1 000 000
Natural gas	1000 cubic feet	3 007 086	766 579
Petroleum	Barrels	1 043 088	1 721 095
Pyrite	Long tons	11 798	35 550
Salt	Barrels	9 013 993	2 131 650
Roofing slate	Squares	16 248	57 771
Slate manufactures	....	....	4 150
Sand-lime brick	Thousands	17 080	122 340
Granite	....	....	255 189
Limestone	....	....	2 963 829
Marble	....	....	460 915
Sandstone	....	....	1 976 829
Trap	....	....	847 403
Talc	Short tons	64 200	541 600
Other materials*a*	....	....	1 850 000
Total value	....	....	$37 132 832

a Includes apatite, arsenical ore, carbon dioxid, diatomaceous earth, fullers earth, marl and sand and gravel exclusive of glass sand.

Mineral production of New York in 1907

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	2 108 450	$2 214 090
Natural rock cement	Barrels	1 137 279	757 730
Building brick	Thousands	1 366 842	7 424 294
Pottery	....	....	2 240 895
Other clay products	....	....	3 023 679
Crude clay	Short tons	3 927	6 163
Emery	Short tons	1 223	13 057
Feldspar and quartz	Long tons	8 723	36 230
Garnet	Short tons	5 709	174 800
Glass sand	Short tons	1 200	1 380
Graphite	Pounds	2 950 000	106 951
Gypsum	Short tons	323 323	751 556
Iron ore	Long tons	1 018 013	3 750 493
Millstones	....	....	21 806
Metallic paint	Short tons	5 269	59 521
Slate pigment	Short tons	620	3 700
Mineral waters	Gallons	8 000 000	1 000 400
Natural gas	1000 cubic feet	3 052 145	800 014
Petroleum	Barrels	1 052 324	1 736 335
Pyrite	Long tons	49 978	162 430
Salt	Barrels	9 657 543	2 449 178
Roofing slate	Squares	11 686	53 625
Slate manufactures	....	....	1 175
Sand-lime brick	Thousands	16 610	109 677
Granite	....	....	195 900
Limestone	....	....	3 182 447
Marble	....	....	1 571 936
Sandstone	....	....	1 998 417
Trap	....	....	941 627
Talc	Short tons	59 000	501 500
Other materials[a]	....	....	1 850 000
Total value	....	....	$37 141 006

[a] Includes apatite, arsenical ore, carbon dioxid, diatomaceous earth, fullers earth, marl nd sand and gravel exclusive of glass sand.

Mineral production of New York in 1908

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	1 988 874	$1 813 622
Natural rock cement	Barrels	623 588	441 136
Building brick	Thousands	1 066 533	5 200 951
Pottery	....	....	1 653 241
Other clay products	....	....	2 064 671
Crude clay	Short tons	4 697	11 605
Emery	Short tons	690	8 860
Feldspar and quartz	Short tons	16 413	68 148
Garnet	Short tons	2 480	79 890
Graphite	Pounds	1 932 000	116 100
Gypsum	Short tons	318 046	760 759
Iron ore	Long tons	697 473	2 098 247
Millstones	....	....	18 341
Metallic paint	Short tons	5 750	54 500
Slate pigment	Short tons	922	7 376
Mineral waters	Gallons	8 007 092	877 648
Natural gas	1000 cubic feet	3 860 000	987 775
Petroleum	Barrels	1 160 128	2 071 533
Pyrite	Long tons	23 775	104 798
Salt	Barrels	9 005 311	2 136 736
Sand and gravel	....	....	1 130 291
Sand-lime brick	Thousands	8 239	55 688
Slate	....	....	111 217
Granite	....	....	367 564
Limestone	....	....	3 119 835
Marble	....	....	692 857
Sandstone	....	....	1 711 585
Trap	....	....	723 773
Talc	Short tons	70 739	697 390
Other materials*a*	....	....	333 648
Total value	....	....	$29 519 785

a Includes apatite, carbon dioxid, diatomaceous earth and marl.

Mineral production of New York in 1909

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	2 061 019	$1 761 297
Natural rock cement	Barrels	549 364	361 605
Building brick	Thousands	1 518 023	8 159 096
Pottery	....	....	1 827 193
Other clay products	....	....	2 365 193
Crude clay	Short tons	12 174	11 585
Emery	Short tons	892	10 780
Feldspar and quartz	Short tons	16 111	52 444
Garnet	Short tons	3 802	119 190
Graphite	Pounds	2 342 000	140 140
Gypsum	Short tons	378 232	907 601
Iron ore	Long tons	991 008	3 179 358
Millstones	....	....	19 247
Metallic paint	Short tons	6 560	65 600
Slate pigment	Short tons	1 155	9 130
Mineral waters	Gallons	9 019 490	857 342
Natural gas	1000 cubic feet	3 825 215	1 045 693
Petroleum	Barrels	1 160 402	1 914 663
Salt	Barrels	9 880 618	2 298 652
Molding sand	Short tons	468 609	437 402
Sand-lime brick	Thousands	12 683	81 693
Roofing slate	Squares	21 187	126 170
Slate manufactures	....	....	880
Granite	....	....	479 955
Limestone	....	....	3 300 383
Marble	....	....	380 016
Sandstone	....	....	1 839 798
Trap	....	....	1 061 428
Talc	Short tons	65 000	617 500
Other materials[a]	....	....	1 483 000
Total value	....	....	$34 914 034

[a] Includes apatite, carbon dioxid, diatomaceous earth, marl, pyrite, and sand and gravel exclusive of molding sand.

SOME LIMITATIONS OF THE MINING FIELD IN NEW YORK STATE

With its varied and important mining industry, the State still affords room for new enterprise. The resources of nearly all the useful minerals represented within its boundaries are so abundant as to assure an indefinitely long life for productive operations. Through advances in technology, improved transportation facilities and the natural growth of markets additional sources of supply are being brought constantly within the zone of economic development; in these ways a widening field of industrial opportunity is provided for energy and capital.

It seems hardly necessary to mention, however, that the mineral wealth of the State has its natural limitations which are of fundamental import to industry. The valuable deposits are not only restricted as to variety, but their areal distribution is conditioned by the nature of the local rock formations or other features that have been more or less well defined from scientific inquiry and explorations. A knowledge of the geological conditions surrounding the occurrence of the useful minerals is very necessary to the proper conduct of field operations. In these days of the expert practitioner, mining bureaus and geological surveys, guidance can easily be had. Few states have been so carefully studied in regard to geology and mineral occurrence as New York, and the accumulated information is largely on record and available to the public.

Yet the neglect of these obvious considerations is by no means uncommon, whereby results much wasted effort with very considerable financial loss. Organizations of capital are effected, costly construction work and development are entered upon frequently without any adequate basis for operations or knowledge of the conditions pertaining to the particular field so essential to success.

A recurring illustration of this tendency is afforded by the attempts which are made from time to time to develop coal beds in the State. The futility of such purpose, however well intentioned, was exposed by the work of the First Geological Survey in the early part of the last century and has been frequently emphasized since; yet there is still a manifest willingness to engage in unprofitable ventures of this kind. The fact that the New York series of rock formations does not contain representatives of the productive coal measures rests upon the most secure basis. But if further evidence be required it may be said that practically the whole of the New York section of stratified formations has been explored in outcrop, mine shafts or drill holes, so that all possibility of the existence of valuable deposits is absolutely removed.

Among the regions which are favored for such operations and which have recently received attention may be mentioned the Hudson River shale region, the Catskills and the southern part of the State along the Pennsylvania boundary. The belt of shales extending along the Hudson river from the Highlands northward to Washington county contains more or less carbonaceous matter, but never in sufficient amount to constitute a true coal. Where the shale has been crushed and compressed the carbon may be noticeable as a thin film on the surface of the shale fragments, giving the appearance somewhat of shiny anthracite, though a purely superficial one.

In the Catskills and the southern tier of counties we have a series of bedded formations which most closely approximate in period of deposition the Appalachian coal measures that are so productive in Ohio, Pennsylvania and the states to the south. Yet they all were laid down before the opening of the coal-making period proper, as shown by the respective stages of life development evidenced in the rocks.

The northern limits of the Appalachian fields geographically approach within such short distance of the New York boundary that some excuse existed for the search for coal before the time of geological surveys; now it can only be a matter of regret that the boundary should have been so discriminately fixed, when the addition of only a few minutes of latitude on the south would have brought portions of this wealth into the State.

Though deficient in coal some of the local formations contain valuable oil and gas pools which support a fairly important productive industry. The discovery of illuminating gas in the State dates back to as far at least as 1821 when wells were drilled at Fredonia, Chautauqua co., probably the first successful attempt to utilize the material in this country. There are now more than 1000 wells that supply natural gas for fuel and lighting purposes besides many more whose output is consumed on the ground for pumping oil. The petroleum industry was first started about 1865 in Cattaraugus county and is now represented by fully 10,000 active wells.

There is thus a solid basis for exploration and development of these resources and it is creditable to local enterprise that they have been brought to such a high state of productivity. The practical oil and gas prospector with his knowledge that comes from accumulated experience has been the chief factor in this achievement. Scientific study of the accumulations of oil and gas has yielded, however, some valuable information, though for the most part perhaps its data have only an indirect or negative application to field exploration. It may and often does help to establish the limit within which drilling operations should be conducted; it provides the means for identifying the productive strata and for tracing their bounds; and from the structure of the formations may point out the more promising places for exploration.

Both the results of such study and past experience show that only a part of the State can be considered as a profitable field for exploration. The areas comprised within the Adirondacks and the Highlands are of course absolutely barren territory, as they are

made up of crystalline rocks. The bordering areas of thin or disturbed sediments afford very little chance of productive wells and this is equally true of the great mass of shales and sandstones that constitute the Hudson River formation, between the Adirondacks and the Highlands. Small pockets of gas have been found occasionally in the shales, but in every case they have played out quickly when tapped by the drill. The territory immediately west of these areas and extending as far as the meridian running through the middle of Oneida lake is of doubtful value and has been explored only in places; the results of test wells so far have been disappointing as regards the existence of gas in quantity.

The productive fields of natural gas that have been discovered up to the present time are restricted to the central and western counties of which there are 15 or 16 that support an active industry. The extreme easterly localities are in Oswego county, where a few small pools have been found near the shore of Lake Ontario. The largest wells are all in the western section, chiefly in Erie, Chautauqua, Cattaraugus and Allegany counties, and it is only in that part that the industry has achieved any marked success.

The oil fields of New York are even more limited. No pools have been found outside of southern Cattaraugus and Allegany counties and a small area in southwestern Steuben county. There has been no notable addition to the producing territory in many years; it seems scarcely probable that the industry will ever be extended much beyond the present bounds.

Another matter which has assumed some importance in relation to the mining industry and should have careful consideration at this time is the reputed presence of gold sands in the Adirondacks. They can not be considered exactly a new development, since a good deal of attention was given them about 12 years ago during the Klondyke excitement; but public interest has been revived recently by attempts to start fresh enterprises which have received frequent notice in the press.

While discussions of the subject have already appeared from this office, the numerous requests for information indicate a need for further publicity of the facts so far as they can be learned.

It is well known that the stream valleys and lake basins of the Adirondacks are choked with gravel and sand deposits. These have been formed by the erosive action of water and ice upon the local rock formations, chiefly granites, syenites, gabbros and gneisses, with some much altered sediments. Quartz is naturally the main con-

stituent of the sands; but several other minerals occur in small amount, such as garnet, magnetite, pyroxene and hornblende which are common in the Adirondack rocks. No minerals have been found in the sands that are foreign to the region. The view expressed as to their derivation from the local rocks is, therefore, well established.

Gold quartz veins are not known in the Adirondacks or anywhere within the immediate region. Common white or milky quartz is rather plentiful, but it lacks the rusty, honeycombed appearance of gold quartz as well as the iron and copper sulphides with which the precious metals are associated in veins that have not undergone surface alteration. It is very likely that careful analysis would show a trace of gold in the Adirondack veins, but they are not mineralized in the usual sense of the term.

To explain the presence of gold in the sands in any appreciable amount we must perforce look for its source in the ordinary country rocks — the deep seated igneous masses and the gneisses and schists. That gold should be generally distributed through rocks of this character to the value of even $1 a ton is certainly an exceptional, if not unique, phenomenon. And yet the basis of present and past mining operations in the region is the claim that the sands, from almost any section, apparently, will yield to proper treatment as much as $4 or $5 and even as high as $40 a ton.

There is a very wide discrepancy between these claims and the results obtained by reputable assayers. This is said to be due to the fact that the gold exists in a peculiar condition owing to which the ordinary methods of fire or wet assay are inapplicable to its recovery. Without inquiry further into that matter at present, we give here some determinations made by disinterested commercial chemists.

In an investigation for the State Museum of the so called "Sutphen" process which was in vogue during the earlier period of experimentation with these sands, J. N. Nevius collected samples from deposits at Hadley that were said to yield $7.50 a ton by that process. The following statements are extracted from his report:

A sample of sand collected from the spot from which the mill's supply is obtained was assayed for the Museum, and the value was reported to be a "trace" of gold to the ton, which means a value of less than 20 cents a ton. No value of silver was obtained. Another sample of the same sand was tested by Dr E. J. Wheeler, of Albany, for the presence of bromin, but no trace of

this element was detected. These two tests prove that the Hadley sand does not contain bromid of gold to the value of $7.50 a ton. In just what chemical combination or physical condition the gold could exist in the sand to the value of $7.50 a ton, and would not be detected by the fire assay, but, after undergoing a simple chemical operation, would be susceptible to amalgamation in paying quantities, is a question which remains for the people interested in this process to explain, before the scientific world, whose confidence rests implicitly on the accuracy of the fire assay, will credit their theory.

For analyses of sands from Lewis county, which is the scene of present activity in mining, we are indebted to *The Engineering & Mining Journal* (March 19, 1910) through whose enterprise samples were recently collected and assayed. The samples were taken by B. J. Hatmaker who had previously experimented with sands from the same localities. The following particulars are from Mr Hatmaker's letter transmitting them:

The samples marked "A" are from an immense deposit along the Black river and represent three samples taken 300 feet apart. These samples gave me, by fire, from $3.59 to $3.80 per ton. The samples marked " B " are from a deposit back in the hills which should run around $3. This particular sample was taken by Professor Locke, of the Boston Institute of Technology, and myself. It represents the sand of which Dr N. S. Keith, of Philadelphia, has milled several tons and has reported $2.50 to $3 recovery, by amalgamation. My fire assays in this have run $1.50 and $2.75. Professor Locke was unable to get more than a trace.

The report on the results of assay by the firm of Ricketts & Banks, as printed in *The Engineering & Mining Journal*, is as follows:

The samples of sand marked "A" and " B," received sealed under signature of B. J. Hatmaker, submitted for assay contain:

	"A"	"B"
Fire assay	0.005 oz.	0.005 oz
Wet assay	0.005 oz.	0.005 oz

gold per ton of 2000 pounds.

Additional samples marked " A " and " B " were also submitted by *The Engineering & Mining Journal* to the firm of A. R. Ledoux & Co. who made the following report:

The two samples of sand submitted to us on February 1, 1910, marked respectively "A" and "B," and sealed with paper bands, bearing the signature of B. J. Hatmaker, have been assayed by the usual fire assay method, yielding:

"A"—Gold = 0.0025 oz. per ton = $0.05 per ton

"B"—Gold = 0.005 oz. per ton = $0.10 per ton

This work was very carefully done, using large assay charges. In view of the statement that these sands are said to contain gold combined with some element, or elements, causing the gold to volatilize during the fire assay process, and that this method is not capable of detecting gold in these sands, we have repeated the assays by a wet method which involves digestion of the finely ground sands with *aqua regia* at a low temperature for a long time, filtering off the acid liquid, evaporating it to small bulk and examining the concentrated solution for gold. By this method we obtained:

In sample "A"—gold, trace

In sample "B"—gold 0.003 oz. per ton = $0.06 per ton.

Supplementing these tests, a portion of each sample was concentrated by panning and the concentrates were examined both with a hand glass and also microscopically. Neither sample showed the presence of any visible gold or of any usual mineral or substance which might possibly carry gold. The concentrates are principally magnetic iron particles mixed with some complex silicates of the garnet family.

Portions of each sample contained in closed tubes of hard glass were heated in a blast lamp flame to the melting point of the glass. A quantity of combined water condensed on the cool parts of each tube but neither sample yielded any sublimate of volatile matter whatever.

From the above tests we conclude that these samples are ordinary silicious sands and that they contain only traces of gold as are usually found in such sands. Traces of gold are frequently present in many rocks and sands, and it is not unusual to find gold values equivalent to a few cents per ton in ordinary rocks, such for instance, as granite paving blocks. These samples do not contain any extraordinary or unusual element or any substance which could cause the gold to volatilize in the ordinary process of assaying, nor in fact do they contain any volatile substance except combined water.

These results are certainly concrete and illuminative. Regarding the methods by which they were obtained, it seems sufficient to say that they are accepted and employed generally in chemical laboratories and that they have stood the test of long practice in all the mining regions of the world.

Without indulging in criticism of the good faith of those who have been at work on the Adirondack sands, we are unable to find in the notices of the press or in any literature which has been circu-

lated for the purpose of informing the public as to their claims, any satisfactory explanation of the processes employed for recovery of the gold which would account for the wide variance between their reported results and those obtained by the usual assay methods. We have been informed recently on creditable authority that in the so called " Sutphen " process, which was extensively advertised about 10 years ago, the methods consisted briefly of pulverizing the sand and amalgamation after treatment with a hot sodium carbonate solution. It was stated that the gold had a silicious coating which necessitated fine grinding and chemical treatment before amalgamation was effective. Even if that were true, there is no reason why the gold should not be set free by fire assay. On the other hand the claim that the gold exists in volatile state, something entirely new to chemical science, seems to be met and controverted by the recent assays.

The economic record of past enterprise in this field is certainly not reassuring to those intent on new ventures. Though it is impossible to give an accurate estimate of the outlay of capital represented by previous experiments, the total must amount to several hundred thousand dollars. An idea of the wide interest which the early enterprises aroused may be gained from the official records which show that over 4000 claims to gold and silver discoveries, mainly within the Adirondacks, were filed in the year 1898. We know of no instance where the public has received any financial return for its investment.

CEMENT

After the setback of 1908, a decided improvement in the cement trade seemed to be the natural order for last year. The market was undoubtedly somewhat broader, inasmuch as manufacturers found a more ready outlet for their product and were able also to reduce considerably the stocks that had accumulated during the previous year, but otherwise the conditions were not much changed. Prices continued at a low level, with a slight upward tendency in the later months. The disparity between productive capacity and consumption was accountable for the continuance of a depressed market. This condition seems to have been removed, or to have been greatly relieved at any rate, and the outlook for the trade at the opening of 1910 was more encouraging than it had been during the last two years. It may be said that local manufacturers enjoyed some advantages in marketing

their output by reason of the numerous large engineering developments in connection with the canal system, municipal water supply plants, hydroelectric installations, etc., that have been in progress recently throughout the State.

During the last few years the cement industry of New York has undergone radical changes. The manufacture of natural cement used to be the principal branch of the industry and was represented by many large and well equipped plants, with an average output of over 4,000,000 barrels a year. The output of the Rosendale district of Ulster county especially found a wide market. With the growth of the portland cement industry in this country, increased competition has so reduced prices that there is now very little margin between the cost to the consumer of that article and the natural cement. As a consequence the sales of the latter have decreased to a fraction of the former quota and most of the plants have been permanently closed.

The manufacture of portland cement on the other hand has grown rather steadily, though not so rapidly as to counterbalance the loss in the output of natural cement. That branch of the industry has been largely centralized in eastern Pennsylvania, where it was first established. For the last year or two increased interest has been shown, however, in the development of the local resources and there is little doubt that New York will eventually take a more prominent place in the trade, which it should occupy by reason of its abundance of raw materials and its market advantages. The erection of a new plant in the Hudson river region, with a reported capacity of 5000 barrels a day, has been underway during the last year.

The total production of cement in New York in 1909 was 2,610,383 barrels, or about the same as in the preceding year when it amounted to 2,612,462 barrels. In 1907 the quantity was reported at 3,245,729 barrels and in 1906 at 4,114,939 barrels. The accompanying table gives the annual output and value for each kind of cement since 1890. There were altogether 13 firms who reported a production last year, the same number as in 1908, but a loss of five as compared with those so reporting in 1907.

In the portland cement industry there was a slight gain of output, the aggregate amounting to 2,061,019 barrels valued at $1,761,297 against 1,988,874 barrels valued at $1,813,622 for 1908. With the placing in operation of the new plant at Green-

port near Hudson which is expected during the current season, a further increase should be registered for this year. This plant will be operated by the New York-New England Cement & Lime Co., under control of Pennsylvania interests. The other projects in the Hudson river region, mentioned in the review of last year, have not been so far advanced as to make them a probable factor in the industry during 1910.

The output of natural cement showed a continuance of the decline which has been underway since the beginning of the present decade. The total was 549,364 barrels valued at $361,605, against 623,588 barrels valued at $441,136 in 1908. Three companies in the Rosendale district contributed 487,864 barrels to the total; Onondaga and Erie counties contributed the remainder.

Production of cement in New York

YEAR	PORTLAND CEMENT		NATURAL CEMENT	
	Barrels	Value	Barrels	Value
1890	65 000	$140 000	3 776 756	$2 985 513
1891	87 000	190 250	3 931 306	3 046 279
1892	124 000	279 000	3 780 687	3 074 781
1893	137 096	287 725	3 597 758	2 805 387
1894	117 275	205 231	3 446 330	1 974 463
1895	159 320	278 810	3 939 727	2 285 094
1896	260 787	443 175	4 181 918	2 423 891
1897	394 398	690 179	4 259 186	2 123 771
1898	554 358	970 126	4 157 917	2 065 658
1899	472 386	708 579	4 689 167	2 813 500
1900	465 832	582 290	3 409 085	2 045 451
1901	617 228	617 228	2 234 131	1 117 066
1902	1 156 807	1 521 553	3 577 340	2 135 036
1903	1 602 946	2 031 310	2 417 137	1 510 529
1904	1 377 302	1 245 778	1 881 630	1 207 883
1905	2 117 822	2 046 864	2 257 698	1 590 689
1906	2 423 374	2 766 488	1 691 565	1 184 211
1907	2 108 450	2 214 090	1 137 279	757 730
1908	1 988 874	1 813 622	623 588	441 136
1909	2 061 019	1 761 297	549 364	361 605

CLAY

BY HENRY LEIGHTON

New York State has an abundance of clay deposits suitable for the manufacture of all materials not requiring a white-burning or a refractory clay.

The Hudson river and Champlain depression furnish excellent red-burning clays for brickmaking and for a few other special uses, while glacial clays, both buff and red-burning, are widely distributed throughout the remainder of the State.

White-burning and refractory clays are found in the State only on Long Island and Staten Island. The irregular pockety nature of the deposits and the extensive use of New Jersey material have limited the use of these clays but their proximity to New York city may in time bring them into more prominence. Notwithstanding the lack of suitable clays near at hand, a number of porcelain, china and fire brick manufactories are in operation in the State and their production is constantly increasing.

The use of the Devonic shales of western New York for the manufacture of tile, paving brick, terra cotta etc., is continuing to increase and the value of shale brick as a high grade building material is becoming more widely known.

Production of clay materials

During the past year the clay-working industry partially recovered from the depression experienced in 1908. Building operations, as shown by the building permits granted, showed a largely increased activity. In New York city in May 1909, 352 buildings with an aggregate value of $18,620,491, were erected as against 204 with a value of $7,585,150 in 1908, or a gain of 145 per cent. In the same month, buildings erected in Buffalo showed a gain over the corresponding month of 1908 of 23 per cent. During the whole year the percentage of gain in building operations was most noticeable. This activity was reflected strongly on the output of structural clay materials and a return to nearly the production of 1907 was made.

The aggregate value of all clay manufactures in 1909 was $12,351,482 against $8,918,863 in 1908 and $12,688,868 in 1907. The number of firms or individuals engaged in the industry was 232 against 242 in 1908, while 42 of the 61 counties in the State participated in the industry. Examination of the output classified as to classes of material, brings out the fact that the increase was felt mainly among the structural materials. Common and front brick, architectural terra cotta, fireproofing, building tile and pottery all show large advances over the year 1908. Common brick shows the largest increase, being valued

at $8,009,766 against $5,064,194 in 1908. Front brick increased from $136,757 in 1908 to $149,330 in 1909; terra cotta from $709,360 in 1908 to $962,497 in 1909; fireproofing from $91,377 to $166,025. On the other hand, products not directly used in building operations, with the exception of pottery, showed a decreased output. Fire brick and stove lining were produced to a value of $486,894 against $545,951 in 1908; drain tile amounted to $268,589 against a production in 1908 of $273,134; paving brick had an output of $207,970 against $211,289 in 1908; and sewer pipe amounted to $117,324 against $133,716 in 1908.

Ulster continues to hold first place among the counties in total production of clay materials, the total value reported from it for the year being $1,620,468, a large gain over the year 1908. As in 1908 Rockland county held second place with an output of $1,488,457; Dutchess county with an output of $880,707 took third place while Onondaga was fourth with a value of $834,111. Other counties reporting productions of over $400,000 were Orange ($814,440); Erie ($753,362); Albany ($750,754); Richmond ($698,991); Kings ($490,946); Columbia ($472,280); Westchester ($438,243) and Queens ($435,182). The output of the first three counties, Ulster, Rockland and Dutchess, is made up almost wholly of common brick, while Onondaga county, the fourth in rank, produces large quantities of china ware.

Production of clay materials

MATERIAL	1907	1908	1909
Common brick	$7 201 525	$5 064 194	$8 009 766
Front brick	222 769	136 757	149 330
Vitrified paving brick	184 306	211 289	207 970
Fire brick and stove lining	624 033	545 951	486 894
Drain tile	162 167	273 134	268 589
Sewer pipe	463 500	133 716	117 324
Terra cotta	1 224 300	709 360	962 497
Fireproofing	45 672	91 377	166 025
Building tile	215 126	70 162	54 397
Miscellaneous	104 575	29 680	101 497
Pottery	2 240 895	1 653 241	1 827 193
Total	$12 688 868	$8 918 863	$12 351 482

Production of clay materials by counties

COUNTY	1907	1908	1909
Albany	$540 341	$538 213	$750 754
Allegany	111 751	44 627	22 601
Broome	8 250	a	nil
Cattaraugus	41 234	a	a
Cayuga	14 832	13 280	15 400
Chautauqua	113 350	128 866	118 897
Chemung	88 940	89 000	61 000
Clinton	4 250	3 920	a
Columbia	433 357	283 720	472 280
Dutchess	781 262	605 371	880 707
Erie	786 703	632 048	753 362
Fulton	2 000	a	a
Greene	237 620	113 373	346 982
Jefferson	20 352	17 897	11 175
Kings	574 863	416 474	490 946
Livingston	a	53 555	6 900
Madison	32 000	12 550	a
Monroe	583 664	240 087	278 991
Nassau	105 000	71 390	136 375
Niagara	16 282	10 892	22 923
Oneida	98 315	88 606	83 500
Onondaga	1 331 443	734 880	834 111
Ontario	342 810	214 246	196 345
Orange	789 297	747 637	814 440
Queens	a	a	435 182
Rensselaer	321 016	233 995	317 559
Richmond	1 121 524	587 919	698 991
Rockland	1 258 467	800 603	1 488 457
Saratoga	256 275	245 878	335 670
Schenectady	83 637	238 750	322 549
Steuben	186 124	166 544	205 036
Suffolk	127 610	125 430	68 370
Tompkins	7 100	a	a
Ulster	1 324 476	819 947	1 620 468
Warren	25 000	a	a
Washington	22 990	11 295	10 950
Westchester	390 773	226 062	438 243
Other counties*b*	505 960	401 808	112 318
Total	$12 688 868	$8 918 863	$12 351 482

a Included under "Other counties."
b Includes in 1907 Genesee, Herkimer, Livingston, Montgomery, New York, Queens, St Lawrence, Seneca and Wayne counties. In 1908, aside from counties marked *a* are included Genesee, Herkimer, Montgomery, New York, St Lawrence, Tioga and Wayne counties. In 1909, aside from counties marked *a* includes Genesee, Montgomery, New York, St Lawrence, Tioga and Wayne counties.

Manufacture of building brick

The output of common building brick in 1909 amounted to 1,507,126,000 valued at $8,009,766, a production exceeding that of any previous year with the exception of 1906. The production in 1908 was 1,056,769,283 brick valued at $5,064,194 while

that for 1907 amounted to 1,351,591,000 with a value of $7,201,-525. In addition to the common brick there were manufactured in 1909, 10,897,000 front brick valued at $149,330 as against 9,763,649 valued at $136,757 in 1908. The total output of brick used for building purposes was, therefore, 1,518,023,000 brick valued at $8,159,096 against 1,366,842,000 valued at $7,424,-294 in 1908. The manufacture was carried on by 180 companies or individuals in 36 counties. In 1908, 196 plants were in operation in 37 counties.

The average price per thousand, received for the common brick in 1909, as based on sales at the yard was $5.31 as against $4.79 in 1908 and $5.33 in 1907. The average value of the front brick was $13.70 a thousand against $14 in 1908 and $14.61 in 1907.

Production of common building brick

COUNTY	1908 Number	1908 Value	1909 Number	1909 Value
Albany	55 677 000	$255 013	80 343 000	$429 554
Cayuga	1 309 000	8 480	1 612 000	10 200
Chautauqua	8 046 011	50 919	7 815 000	52 047
Chemung	14 833 000	89 000	10 500 000	61 000
Clinton	640 000	3 920	250 000	1 500
Columbia	61 971 000	283 720	88 026 000	472 280
Dutchess	132 003 973	605 371	170 615 000	876 207
Erie	35 960 325	202 943	43 379 000	243 786
Greene	12 094 825	57 923	42 794 000	246 982
Jefferson	2 321 749	17 897	1 450 000	11 175
Livingston	490 000	3 555	1 100 000	6 700
Monroe	15 617 815	93 730	23 493 000	126 950
Nassau	11 675 000	63 890	20 000 000	118 560
Niagara	1 543 014	10 892	3 368 000	22 923
Oneida	17 436 000	83 731	16 000 000	83 500
Onondaga	14 028 000	76 030	22 800 000	154 250
Ontario	2 768 000	16 946	2 350 000	14 200
Orange	151 869 000	747 637	164 680 000	814 440
Rensselaer	10 949 400	60 723	19 895 000	102 225
Richmond	25 398 500	89 083	37 500 000	170 475
Rockland	173 926 094	800 603	275 262 000	1 488 457
Saratoga	51 034 000	243 728	70 539 000	333 728
Steuben	2 651 080	21 870	3 480 000	30 132
Suffolk	20 108 150	122 430	11 870 000	68 370
Ulster	179 165 560	816 947	304 904 000	1 620 468
Westchester	39 801 577	184 774	72 265 000	392 577
Other counties[a]	9 452 400	52 639	10 836 000	57 080
Total	1 056 769 283	$5 064 194	1 507 126 000	$8 009 766

[a] Includes in 1908, Allegany, Broome, Fulton, Herkimer, Montgomery, St Lawrence, Schenectady, Tioga, Tompkins, Warren and Washington. In 1909 the following counties are included: Allegany, Cattaraugus, Fulton, Montgomery, St Lawrence, Steuben, Tioga, Tompkins, Warren and Washington.

Hudson river region. By far the greater part of the output of common brick comes from nine counties bordering the Hudson river from Albany and Rensselaer counties southward. In this area the banks of the river are made up of a series of terraced deposits of clay with occasional sands or gravels. This more or less continuous clay bed is one of the most extensive in the United States and supports a brickmaking industry second to none in America or Europe.

The clays which are very constant in character are bluish in color, weathering to red at the surface and are rather calcareous

containing usually about 4 to 5 per cent of calcium oxid. They burn to a good red color, incipient fusion taking place at cone .05 and vitrification at .04. Besides the main use as material for soft mud brick, the clay has been successfully utilized in the manufacture of roofing tile and certain beds are used as a slip clay for glazing pottery.

The brick are manufactured entirely by the soft mud process and are burned in scove kilns, modern methods seemingly taking slight hold in the district.

The importance and growth of the industry in the region has been due to the ease with which the clay can be mined from the terrace, manufactured practically on the dock, and loaded directly onto barges and shipped to New York city.

The year 1909 showed a marked improvement in business conditions and an increased activity in building operations. This activity was felt in the Hudson river yards and a much larger output of brick was made. The total output was 1,218,-784,000 brick valued at $6,443,190 of which all but 210,000,000 were shipped, reliable estimates giving that amount as held over. This would give as the total sales 1,008,784,000 as against 817,459,000 in 1908. The figures in the tables for 1909 represent the total manufactured while in 1908 they are given as the total sold.

The increased output was accompanied by such an increased demand that prices showed a gratifying increase, the average price per thousand being $5.28 against $4.75 in 1908 and $5.20 in 1907. There were 119 plants in operation with an average production of 10,326,000, against 114 plants with an average output of 7,171,000 in 1908. As in former years Ulster county had the lead in production with a total of 304,904,000 brick valued at $1,620,468, against 179,166,000 valued at $816,947 in 1908. Rockland county held second place as heretofore, while Dutchess county ranked third, displacing Orange county which held third place in 1908.

Output of common brick in the Hudson river region in 1908

COUNTY	NUMBER OF PLANTS	OUTPUT	VALUE	AVERAGE PRICE PER M
Albany	12	55 677 000	$255 013	$4 57
Columbia	4	61 971 000	283 720	4 57
Dutchess	18	132 004 000	605 371	4 58
Greene	4	12 095 000	57 723	4 77
Orange	8	151 869 000	747 637	4 92
Rensselaer	6	10 949 000	60 723	5 54
Rockland	29	173 926 000	800 603	4 60
Ulster	26	179 166 000	816 947	4 55
Westchester	7	39 802 000	184 774	4 64
Total	114	817 459 000	$3 812 511	$4 75

Output of common brick in the Hudson river region in 1909

COUNTY	NUMBER OF PLANTS	OUTPUT	VALUE	AVERAGE PRICE PER M
Albany	12	80 343 000	$429 554	$5 34
Columbia	5	88 026 000	472 280	5 36
Dutchess	19	170 615 000	876 207	5 13
Greene	5	42 794 000	246 982	5 77
Orange	8	164 680 000	814 440	4 93
Rensselaer	6	19 895 000	102 225	5 64
Rockland	30	275 262 000	1 488 457	5 40
Ulster	26	304 904 000	1 620 468	5 31
Westchester	8	72 265 000	392 577	5 43
Total	119	1 218 784 000	$6 443 190	$5 28

Other clay materials

The manufacture of vitrified paving brick was carried on by three companies in Chautauqua, Greene and Steuben counties, as against five companies in 1908. The output was 12,778,000 brick valued at $207,970 against 14,570,140 valued at $211,289 in 1908. The average price per thousand was $14.50 in 1908 and $16.27 in 1909. There was a decided decrease in the production of fire brick and stove lining in the State, the total output of fire brick being $411,796 and of stove lining $75,098 against values of $442,967 and $102,984 respectively in 1908.

Eleven companies were active during the year and the industry showed little change aside from the general decrease in manufacture. The material for these products is all obtained outside of the State, mostly from New Jersey.

The manufacture of drain tile and sewer pipe is carried on in Albany, Cayuga, Erie, Genesee, Kings, Madison, Monroe, Onondaga, Ontario, Saratoga, Washington and Wayne counties. The output of drain tile in 1909 amounted to $268,589 against $273,184 in 1908. Eighteen companies are represented in the output, while the two leading counties were Erie and Ontario. This product is used mainly for underdraining farm land, and the education of the farmer along such lines has been instrumental in recent years in increasing the demand for tile.

Sewer pipe is manufactured in the State by but three firms located in Brooklyn and Rochester. The value of the output in 1909 was $117,324 against $133,716 in 1908 and $463,500 in 1907, a constant decrease for which the underlying cause is not apparent.

Fireproofing, including terra cotta lumber, hollow brick, and various other kinds of hollow terra cotta fireproofing, is manufactured mainly from local materials, in Erie, Kings, Monroe, New York, Onondaga and Rensselaer counties, six firms being represented in the output. The output for the year was $166,025 against $91,377 in 1908. The output for 1909, however, includes some hollow brick, heretofore included with common building brick.

Building tile, including roofing tile, vitrified floor tile and a terra cotta tile similar to fireproofing was manufactured in Allegany, Kings and Monroe counties by six firms. The total value of the output for 1909 was $54,397 against $70,162 in 1908.

The roofing tile industry is one deserving more prominence among the clay-working activities of the State. Two firms, the Alfred Clay Co., and the Ludowici-Celadon Roofing Tile Co., manufacture this product at Alfred, Allegany co., while in Malden, Ulster co., the industry has, in recent years, been undertaken. One firm, the German American Roofing Tile Co., is at present turning out a good grade of tile from a small plant but as yet supplies only a local trade. Roofing tile are becoming more popular in this country on account of their beauty and durability, and with suitable clays at hand at both Malden and Alfred, a larger industry should be established. The plant of

the Ludowici-Celadon Co. was destroyed by fire in the fall of 1909 and has not yet been rebuilt.

Vitrified floor tile are manufactured by but one firm, the Brooklyn Vitrified Tile Works of Brooklyn.

Architectural or ornamental terra cotta is manufactured by three large firms located in Queens, Richmond and Steuben counties. The output for the year 1909 amounted to $962,497 against $709,360 in 1908, an encouraging increase.

Pottery

Clays suitable for the finer grades of pottery products, such as china and porcelain ware, are not found to any extent in the State. The clay beds of Long Island and Staten Island have furnished some grades of stoneware clay and these are at times used in the New York and Brooklyn plants. The main supply of material for china making, however, must be shipped in from without the State; the feldspar from Canada, the kaolins from the south, and the stoneware clays from New Jersey.

Of the commoner grades of clay used for red earthenware manufacture, the State has an abundance but the demand for such ware is not sufficient to establish any extensive industry.

The total production of pottery in the year amounted to $1,827,193 as compared with $1,653,241 in 1908, indicating a marked advance. The production came from 23 plants located in the following counties: Albany, Erie, Kings, Nassau, Onondaga, Ontario, Schenectady, Washington and Westchester. Onondaga county continues to lead in production with a total from the six active plants of $671,566 while, Erie, Schenectady, Kings and Ontario counties also have large productions.

The manufacture of stoneware seems to be steadily declining in the State, the production in 1909 amounting to $41,298 or less than one half of the production in 1906.

Red earthenware, consisting mainly of flower pots, shows a production of $32,800 or about the same as has been reported for several years. The increase in production was confined mainly to the white products not made from New York materials, such articles being china tableware, sanitary ware and electrical supplies. The china tableware is made mainly in Buffalo and Syracuse; the electrical supplies in Victor, Syracuse, Schenectady and Brooklyn; and the sanitary ware in New York and Brooklyn.

Value of production of pottery

WARE	1907	1908	1909
Stoneware	$65 271	$44 712	$41 298
Red earthenware	28 296	31 645	32 800
Porcelain and semiporcelain*a*	1 181 162	900 548	999 663
Electric and sanitary supplies	869 378*b*	595 247	697 573
Miscellaneous	96 788	81 089	55 859
Total	$2 240 895	$1 653 241	$1 827 193

a Includes china tableware and cream-colored ware.
b Includes a value of about $200,000 for hardware trimmings used in electric supplies.

Crude clay

In the foregoing tables relating to clay products no account has been taken of the crude material entering into their manufacture. There are a few producers in the State who do not utilize the crude clay themselves but ship their output to others for manufacture. The clay most widely exploited for shipment is the slip clay found within the city limits of Albany and known to the trade as "Albany slip." This clay belongs to the terrace clays of the Hudson valley. It resembles in appearance the general run of Hudson river brick clays, but in chemical composition differs in having much larger percentages of the alkalis, soda and potash. These fluxing impurities give to the material a low fusibility and it is therefore in demand as a natural glaze for stoneware, giving to such products a rich, brown glaze.

In addition to the output of slip clay, refractory and white-burning clays are mined and shipped from Long Island and Staten Island. Kaolin for paper sizing is mined at Shenandoah, Dutchess co., and pottery clays are shipped from various points in the State, shipments in 1909 being made from Warners and Amboy Station, Onondaga co.; Chili, Monroe co.; and Amenia, Dutchess co.

The total production for 1909 amounted to 12,174 short tons valued at $11,585, against 4697 tons valued at $11,605 in 1908. The total tonnage seems to have increased while the value remained the same, which was no doubt due to the fact that a large proportion of the clay shipped in 1909 was of a lower grade and sold at a lower figure. Seven producers figured in

the output, two producing slip clay; one, fire clay; one, paper clay; and three, potters clay.

EMERY

The emery mines in Westchester county increased their output last year by about 200 tons. The product reported was 892 short tons valued at $10,780 as compared with 690 short tons valued at $8860 in 1908. The production was still considerably below the average as the annual shipments have usually exceeded 1000 tons. The poor showing may be attributed to a decrease in the demand for abrasives which was noted as well in other branches of the productive industry.

The statistics of output are based upon the crude material as shipped from the mines where it undergoes only a rough sorting or cobbing. The emery is mainly shipped to Pennsylvania for grinding and manufacture. The producers in 1909 were as follows: Blue Corundum Mining Co., Easton, Pa., Keystone Emery Mills, Frankford, Pa., and the Tanite Co., Stroudsburg, Pa. The Hampden Corundum Wheel Co. of Springfield, Mass., and J. R. Lancaster of Peekskill who in the past have been actively engaged in the industry made no output last year.

The New York emery is a mixture of corundum, spinel and magnetite in varying proportions. It occurs as a hard, dense rock, of dark gray to nearly black color, sometimes showing the corundum in well developed prismatic crystals of lighter shade. The corundum, which of course is the more valuable constituent, may constitute as much as 50 per cent of the entire mass, or it may be subordinate to the other ingredients. The emery occurs in the form of lenses and bands within basic igneous rocks of the gabbro family. It is the result of segregation of the heavier rock minerals, and the deposits are analogous to the bodies of titaniferous magnetites which occur in gabbroic rocks. Some of the deposits, indeed, contain a fairly high percentage of magnetite and were once mined for iron ore, but the material proved too refractory for use in the blast furnace.

FELDSPAR

There was no notable change in the feldspar industry during 1909. The demand for the better quality of feldspar which is used in pottery manufacture continued dull and prices showed

little improvement from the low level of the previous year. The production of this grade consequently did not attain the usual proportions. The quarries of roofing feldspar were more active and the demand for the material seems to have been nearly normal. The greater part of the output belonged to that grade which is really a crushed pegmatite containing more or less quartz, mica and other ingredients in addition to feldspar.

The production for the year amounted to 13,871 short tons valued at $46,444, as compared with 14,613 short tons valued at $53,148 in 1908. There were four companies who contributed to the output, the several quarries being situated in Westchester, Essex and Saratoga counties.

Most of the pottery feldspar was quarried in Westchester county by P. H. Kinkel's Sons, though the Adirondack Spar Co. made a small output from their property at Batchellerville, Saratoga co., also the Crown Point Spar Co., of Crown Point shipped a small quantity which was obtained in the course of operations for the production of roofing materials. The Barrett Manufacturing Co., with quarries near Ticonderoga, produced roofing feldspar alone. In addition to feldspar the shipments from the quarries included some rock quartz and scrap mica. The quartz came from Westchester county and was used for the manufacture of wood filler. The production of mica was reported by the Crown Point Spar Co. as a by-product of milling operations. The combined value of these materials amounted to $7000.

The average value of the pottery grades in 1909 was about $3 a long ton for crude and $6 a short ton for ground feldspar. The crushed feldspar for roofing and poultry grit brought $2.75 and $3 a short ton.

No new quarries were opened during the year and the trade situation gave little encouragement to exploratory work. The only change in the list of producers was occasioned by the transfer of the property formerly worked by the Claspka Mining Co. to the Adirondack Spar Co. of Glens Falls.

GARNET

The abrasive garnet trade in 1909 made some progress toward recovery from the severe depression of the preceding year, but it did not attain great activity. After such an extreme decline a more decided upturn might have been expected. The

general record of the mining industries showed, however, that the improvement was slow during the year and conditions on the whole were scarcely so prosperous as had been depicted in current reports. There was no evidence of any developments unfavorable to the Adirondack garnet mines in particular, and a more active market may be anticipated for the coming season.

The production of garnet last year amounted to 3802 short tons with a value of $119,190. The gain over the output for 1908, which was 2480 tons valued at $79,890, was thus more than 50 per cent, but it may be doubted if the consumption showed a corresponding increase. The total for 1907, the largest on record, was 5709 tons valued at $174,800. Prices remained practically unchanged; they have fluctuated only slightly in recent years, the average being between $30 and $35 a ton.

No new mines were opened in 1909. The producing companies included the North River Garnet Co. with mines at Thirteenth lake; the American Glue Co. and H. H. Barton & Sons who worked properties near North river; and the American Garnet Co. who operated the Smith mine on Mt Bigelow in northern Essex county.

The Adirondack garnet that is mined belongs to the common iron-bearing variety and the better grades have a deep red color. It is associated with a basic rock of which plagioclase feldspar and hornblende constitute the other ingredients. The rock shows the effects of metamorphism and the garnet is probably the result of a recrystallization. The garnet crystals are of variable size; those found on Gore mountain near North river often measure a foot or more in diameter and a single crystal has yielded more than a ton of abrasive; elsewhere in the region the crystals seldom exceed a diameter of 5 or 6 inches. The fact that the garnet is more or less shattered, facilitates its recovery by hand picking which is practised by all but one of the companies. When the large crystals are broken into, they crumble under slight pressure and can be removed from the matrix without much difficulty. The fragments generally exhibit smooth surfaces on one or more sides due to a well developed parting, and this feature adds considerably to the efficiency of the Adirondack garnet for abrasive uses. The fractured condition of the crystals is probably the result of regional compression, evidences of which are ob-

servable in extensive crushing and faulting of the country rocks.

The deposit on Mt Bigelow is of different character than the others. The garnet there is found along the contact of anorthosite in irregular and lenticular bodies that consist in greater part of the single mineral. It has a massive appearance and breaks into granular particles but occasionally shows a platy fracture like the crystal garnet. The principal impurity is a greenish pyroxene. The masses measure as much as 40 feet in thickness. Along with the garnet there are bands of amphibolite and crystalline limestone, the whole assemblage having the appearance of a sedimentary series which has been caught up by the anorthosite during its intrusion and metamorphosed.

The capacity of the mines is much greater than the average output. The production could be raised to 10,000 tons a year without taxing the present facilities. The North River Garnet Co. has the only property that is equipped for work throughout the year. It is the only company also that makes use of mechanical methods for recovery of the garnet. The mines and mill are situated on the slope of a mountain on the east shore of Thirteenth lake. The whole western face of the mountain consists of the garnet rock, the supply of which is practically inexhaustible. The rock is crushed and then run through special types of jigs. Close work is required of these in order to effect a separation of the garnet and hornblende which differ by only half a unit in their specific gravity. The garnet concentrates, however, are brought up to a high degree of purity.

The shipping point for the region is North Creek. The garnet is shipped unsized in bags.

The manufacture of garnet abrasives in this country is limited to a few companies and there is very little demand for the mineral for export. The mining field, therefore, can not offer encouragement to new developments so long as present facilities remain so largely in excess of the market requirements.

In the last two or three years a small quantity of Spanish garnet has been imported into the United States for manufacture. This garnet is said to be obtained from river sands. It is cheaper than the domestic garnet, but on account of its uniformly small size is useful only in a limited way. The imports for the year 1909 amounted to 536 short tons valued at $10,315.

The ports of entry are New York and Boston. The value of the garnet averaged $19.29 a short ton. In 1908 the imports amounted in value to $2095 and in 1907 to $6432.

GRAPHITE

The production of crystalline graphite in the Adirondack region made a good gain last year, but the increase was due to a more active campaign on the part of the principal enterprise and not to any contribution by new mines. There were no important changes in the mining situation. The increase of output, which amounted to about 20 per cent as compared with the total returned for 1908, did not suffice, however, to bring up the production to the record of earlier years. Market conditions were favorable in spite of the general business depression; the best grades of flake graphite from the Adirondacks have always commanded prices above the average and these have shown recently a marked upward tendency.

The American Mine of the Joseph Dixon Crucible Co. occupied, as heretofore, the leading place in the industry. For many years it has been the largest and most successful enterprise of the kind in the country. Its position has been attained through experienced management and the perfection of its methods for the separation and refining of the graphite. It has had also the advantage of an unusually rich deposit for its type, combined with certain features which make the graphite more easily recoverable than is often the case. The quartzite that constitutes the matrix is practically free from other scaly minerals and the graphite flakes are of large size.

Adjoining the American mine on the southwest, the property of W. H. Faxon of Chester, N. Y. has been explored recently with promising results. The same series of quartzites, limestones and gneisses are in evidence, though the graphite deposits appear to occupy a higher position than those of the American mine. That they are not a direct continuation of the latter is apparent from a field examination and is further indicated by slight differences in their character. There are two beds of graphitic quartzite separated by garnetiferous gneiss. The upper or main bed measures from 6 to 14 feet thick; and the lower one about 4 or 5 feet. They are cut off at the southwest end by a diabase dike, near which they are also slightly thrown by a transverse fault. The beds have been exposed along the

outcrop by test pits and explored on the dip by drilling so as to prove their persistence over a large area. The average rock is fairly uniform in graphite which is of somewhat finer flake than that obtained from the American mine. It is planned to make mill tests during the current season; if they are favorable the construction of a large plant and the active exploitation of the deposits may be anticipated.

GYPSUM

The gypsum industry which has advanced very rapidly in the last few years continued its progress during 1909. Though no new mines or quarries began active work within the period, increased operations on the part of the enterprises who recently entered the field, in the natural course of development, brought about a considerable gain of output. Trade conditions were still somewhat unsettled and from that standpoint the showing was better than might have been expected.

The output of crude gypsum amounted to 378,232 short tons, against 318,046 short tons in 1908, an increase for the year of 60,186 short tons or nearly 20 per cent. The production was reported as 323,323 tons in 1907; 262,486 tons in 1906 and 191,860 tons in 1905; so that it has almost doubled within the last five years.

Of the quantity of crude rock that was mined or quarried in 1909 about 70 per cent was converted into calcined plasters by the producing companies. Their reports showed a total of 209,223 tons of plaster of paris and wall plaster manufactured, with a value of $699,110. In 1908 the total was 160,930 tons valued at $574,757. The amount of gypsum ground for land plaster was 9468 tons valued at $19,283, against 5712 tons valued at $14,255 in the preceding year. The quantity sold in crude state for mixture in portland cement and for calcination in plaster mills outside the district was 126,606 tons valued at $189,-208 against 95,146 tons valued at $171,747 in 1908.

Production of gypsum

MATERIAL	1908		1909	
	Short tons	Value	Short tons	Value
Total output, crude	318 046	....	378 232	....
Sold crude	95 146	$171 747	126 606	$189 208
Ground for land plaster	5 712	14 255	9 468	19 283
Wall plaster, etc. made	160 930	574 757	209 223	699 110
Total value	....	$760 759	....	$907 601

The principal developments in the industry in recent years have centered about the western localities, and these now furnish most of the supply. Genesee county is the largest producer of crude gypsum, as well as of manufactured materials, like land plaster, plaster of paris and wall plasters. Its output of crude rock in 1909 amounted to 259,321 short tons. Monroe county which ranked as the second largest producer reported an output of 90,970 short tons. The rest of the gypsum came from Onondaga, Cayuga and Erie counties.

The following brief account of the gypsum resources of the State and their industrial development has been taken from a report, now in press, for the State Museum.

NOTES ON THE GYPSUM DEPOSITS OF NEW YORK

Distribution of gypsum. The workable gypsum beds of New York are found in the Salina stage of the Upper Siluric or Ontaric system. There are two main areas of Salina strata, of which the larger is represented by a belt that extends with unbroken continuity from Albany county through central and western New York to the Niagara river and thence into the province of Ontario. The Salina of this area is mainly a shale formation. The other elements are gypsum which occurs in the upper shale beds, rock salt near the middle of the section, and limestone which is present in the central and western parts as a thin capping to the shale and also occurs in bands of inconsiderable thickness within the shale itself. The sequence is here shown in order from the highest to the lowest member:

5 *Bertie waterlime.* An argillaceous magnesian limestone, possessing hydraulic properties. Its thickness ranges from about 50 feet in Erie county to 10 feet or less in eastern New York. Used for natural cement.

4 *Camillus shale*. Drab, gray, green and red shales with beds of gypsum and dolomite in the upper part. Smaller seams and veins of gypsum are found all through the shale. The total thickness reaches 300 feet in the central part of the State.

3 *Syracuse salt*. An assemblage of alternating beds of rock salt and shale, not definitely delimited with regard to the Camillus and Vernon shales. The presence of rock salt is the only criterion for its recognition. The salt beds have not been found east of Madison county and they occur only under a thick covering where they have been protected from solution.

2 *Vernon shale*. A prominent member of the Salina in the section west from Herkimer county. Has a thickness of 500 feet in Onondaga county. It is distinguished by a bright red color except in the western part where it is banded with gray and green shales and becomes less conspicuous.

1 *Pittsford shale*. A local phase of the Salina, notable only for its Eurypterid fauna. The type locality is near Rochester.

The second area of Salina strata is in southeastern New York and consists of two belts, one of which follows the Shawangunk mountain uplift and the other the parallel Skunnemunk uplift. The principal members are conglomerate, shale and sandstone. No gypsum has been found in this region and in view of the fact that the strata here were accumulated in a separate basin, entirely independent of the other, its presence may be regarded as very uncertain.

General features of the deposits. The gypsum as a rule forms regularly stratified beds which are made up of layers varying from a few inches to 4 feet or so thick. The beds are not, of course, continuous throughout the Salina belt, but have the shape of elongated lenses which follow each other along the strike and dip with intervals in which they may be absent or of greatly diminished size. The workable deposits are thus segregated into more or less well defined areas. When exposed in natural outcrop the beds are apt to show irregularities due to solution of the gypsum by ground waters; in this way the entire removal of the gypsum seems to have resulted in some places where it was only thinly covered by shale or limestone.

The main deposits lie within the upper part of the Camillus shales and as the whole formation has a slight southerly dip (about 1 foot in 100), their line of outcrop is near the southern border of the Salina belt as traced on the map. A useful indicator in the field is the Bertie waterlime which is more resistant to weathering than the shales and which can often be located by the character of the topography. The gypsum usually occurs within a few feet of the base of the waterlime.

The deposits exhibit a considerable variation of character in different parts of the belt. In Madison county, on the eastern end, they consist of a loose friable mixture of gypsum crystals (selenite) and clay, and have originated seemingly by solution and recrystallization of former beds or disseminated gypsum. These deposits

are not well stratified but form pockets and larger masses of lenticular and irregular shape of perhaps a few hundreds of feet in area. In exposure the clear gypsum, freed from the admixed clay, lends a semblance of purity to the deposits which is very deceptive; the actual gypsum content is usually less than 75 per cent. The deposits are worked only as a source of material for land plaster.

The deposits that are worked in Onondaga county and in the counties to the west, belong to the usual stratified type and are more homogeneous than those first described. They are made up of finely divided gypsum fibers or minute crystals forming a felted mass in which the impurities are evenly distributed. The color of the gypsum varies from gray or drab to nearly white.

The maximum development of the gypsum is reached in Onondaga county where there is a single bed 60 feet thick consisting of a number of individual layers which vary somewhat in appearance and color, though they are quite uniform in regard to gypsum content. This bed is exposed in the townships of Dewitt and Manlius, east of Syracuse, where it is quarried for land plaster, for admixture with portland cement, etc. In western Onondaga county, the gypsum as seen in outcrop has a thickness of 15 or 20 feet.

Near Union Springs, Cayuga co., a deposit from 20 to 30 feet thick is worked.

The Salina belt crosses Seneca, Wayne and Ontario counties and deposits of workable dimensions are found at frequent intervals. No production has been made from this section in recent years, though some of the gypsum, notably in Ontario county, is of very good quality. In the town of Victor, two beds, 8 feet and 6 feet thick, have been found by drilling and the drill cores indicated a close resemblance to the gypsum at Garbutt, Oakfield and Akron farther west.

The deposits are encountered in the town of Wheatland, Monroe co. and are there mined on an extensive scale for the manufacture of calcined plasters and for other purposes. Two beds are generally present, separated by 6 feet or more of limestone. The upper bed measuring from 5 to 8 feet thick is mainly worked though the lower bed is of equal size and purity. The area at present developed covers about 3 square miles.

Another important locality is in the town of Oakfield, Genesee co., where a light-colored rock 4 feet or more thick is extensively mined and employed in calcined plaster manufacture. The plaster works near Oakfield Station are the largest in the State.

In Erie county, the whole middle of which is crossed by the Salina belt, mines have been recently opened near Akron, 20 miles east of Buffalo. The bed is 4–5 feet thick, light-colored and well adapted for calcination. It is probable that gypsum occurs also in the interval between Akron and Buffalo, though no records of its discovery have been made known. A series of test wells put

down by the Buffalo Cement Co., at Buffalo several years ago showed two beds of white gypsum each 4 feet thick. The upper bed was encountered at 43 feet from the surface and the lower one at 62 feet, with a 2 foot bed at 49 feet. An attempt to explore the upper bed by a vertical shaft was relinquished after meeting a heavy flow of water and nothing has been done since toward the development of the deposits.

Chemical composition of the gypsum. Analyses of average samples of the deposits from different localities recently made for the State Museum, indicate that the gypsum content ranges between the general limits of 64 or 65 per cent and 95 per cent. The quality seems to improve toward the west. The impurities are mainly clay, lime and magnesia carbonates and quartz.

	1	2	3	4	5
SiO_2	.51	.40	2.93	4.00	8.31
Al_2O_3	1.19	2.97	1.92	1.74	4.53
Fe_2O_3	.79	.77	1.10	1.11	1.34
CaO	30.62	30.76	26.27	29.36	21.50
MgO	1.20	1.53	8.29	2.81	7.20
SO_3	43.59	43.78	33.83	35.79	30.47
CO_2	1.02	2.80	11.02	6.38	9.50
H_2O	20.52	17.53	14.87	17.93	14.53
	99.44	100.54	100.23	99.12	97.38
Gypsum calculated	93.74	94.26	72.84	77.06	65.49

1 Akron, Erie co. 2 Oakfield, Genesee co. 3 Garbutt, Monroe co. 4–5 Lyndon, Onondaga co. Analyses are by George E. Willcomb.

Methods of extraction. The gypsum beds of the eastern section are worked by quarry methods. The smaller pocket deposits have been exploited only in a desultory manner, their yield from year to year depending upon the local market for land plaster. More systematic operations are carried on in connection with the rock gypsum of Onondaga and Cayuga counties. The beds are exposed along the edges of hills with a variable covering of limestone and drift which is stripped off or allowed to fall into the excavation as the gypsum is removed from the face. The gypsum is broken down by drilling and blasting. Power drills of the percussion type and hand drills are both employed. As the quarry advances into the hill an increasing overburden is encountered and in the course of time may become a serious obstacle to the continuation of open quarry work. Operations are then either transferred to a new locality or changed to underground mining.

In the section west of Cayuga county the gypsum is worked underground, by means of an adit where the bed approaches close to the surface, otherwise by a vertical shaft. This method has

also been introduced recently in some of the Onondaga quarries. The main adit entries which serve for haulage are driven from 5 to 8 feet high and from 6 to 10 feet wide. The larger dimensions refer to the mines near Jamesville where the gypsum is excavated in large rooms and removed by 2-horse wagons that are loaded directly at the quarry face. When the beds are only 5 feet or so thick the rock is hauled out on mine cars attached to a cable. The size of the rooms ranges up to 30 feet square. The overlying limestone makes a firm roof and little artificial support in the way of timbering or packing is required.

The mines at Akron, Oakfield and Garbutt are entered by vertical shafts from 50 to 70 feet deep or by adits. The underground workings follow the pillar and room system but are more regularly planned than those of the adit mines. The mines are often electrically lighted, ventilated by forced draft and when necessary are drained by pumps which raise the water from a sump at the shaft bottom. Gas, electricity and steam are used for power purposes, the former being supplied from the natural gas belt of Erie co. Electric locomotives are in use for underground haulage, but in most mines the cars are pushed by hand or drawn by mules. The gypsum is drilled for blasting by either auger or percussion drills. For hoisting from the shafts, a bucket elevator is employed at one mine, while at the others single and balanced platform hoists are generally used. Most of the mines are connected with the milling plants by narrow gage railways.

Manufacture of gypsum plasters. A part of the gypsum from the mines and quarries is shipped in lump form to land plaster mills and portland cement works. The latter are also supplied with crushed gypsum which is shipped in bags. A small part is ground into land plaster by the mining companies. The remainder of the product, which represents the larger quantity, is converted into calcined plaster in plants run in connection with the mines.

The calcined plasters made by the mining companies belong to the half hydrate class, their basis being plaster of paris. No anhydrous plasters like Keene's cement or German flooring plasters are manufactured from the local gypsum. The preparation of plaster of paris requires the two operations of grinding and calcination.

Grinding is accomplished in several stages and if the kettle process of calcination is used the stages follow consecutively until the material is reduced to a fine powder. The coarse crushing is effected by jaw or gyratory crushers. From these the gypsum passes into a "cracker" which resembles a coffee mill and reduces the lumps to about pea size. After this treatment the gypsum is ready for charging into rotary cylinders, but for the kettle process it is next run through a fine grinder of which there are many kinds in use. Buhrstones, the Sturtevant emery wheel, the Williams disintegrator, the Stedman disintegrator and roller mills all find application for gypsum grinding.

The kettle method of calcination is employed by most of the local plaster manufacturers. The kettles are cylinders of boiler iron from 8 to 10 feet in diameter, nearly square in vertical section and set upright in a brick wall. The kettle is charged through a trap in the cover and heat is gradually applied, passing from the fire chamber below into flues which traverse the kettle horizontally, and out through a stack at the top. About 10 tons of gypsum are calcined in a single charge. It is necessary to keep the mass in constant agitation to prevent overburning, which is accomplished by means of a vertical shaft with paddles connected with the mill shafting. The end temperatures range from about 350° to 400° F. The rotary kiln is used in two plants; it possesses advantages in that it is continuous, requires less power to operate and is more economical of heat than the kettle. The type that has been installed is known as the Cummer kiln. The crushed rock passes through the cylinder in about 10 minutes and is discharged into brick-lined bins when the calcination is completed by the residual heat in about 36 hours. The plaster is then ground.

The calcined plaster in part is converted into wall plasters, plaster board, etc., and partly sold as stucco. Wall plasters are made from plaster of paris by the addition of some retarder, an organic or mineral substance which delays the time of setting, and of a fiber, such as hair, shredded wood or asbestos. Plaster boards are formed of layers of paper cemented with plaster of paris.

IRON ORE

The year 1909 was characterized by extreme fluctuations in the iron trade. During the first few months market conditions were little better than in 1908, which was a year of unrelieved depression. The mining companies were unable to contract for more than a fraction of their normal output and consequently operated on a small scale. There was even then a considerable surplus of ore which had to be stocked. By the middle of the year the market had experienced a decided improvement which finally brought an end to the long depression. Mining was then resumed at the usual rate and for the remaining months the demand for ore was sufficient to keep the mines running at their maximum capacity.

The output reported by the mines was 991,008 long tons valued at $3,179,358. This was practically an increase of 300,000 tons over the product for 1908 which amounted 697,473 long tons valued at $2,098,247. The total fell somew short of the output in 1907 but with this exception was largest reported in any year since 1891. The average valu the ore was $3.21 a ton against $3.01 a ton in 1908.

Classified as to variety the production consisted of 934,274 long tons of magnetite valued at $3,043,084 and 56,734 tons of hematite valued at $66,790. A large part of the magnetite (535,812 long tons) was marketed in the form of concentrates with an approximate average content of 65 per cent iron; the remainder (398,462 long tons) was shipped in lump form with a tenor ranging from about 52 to 60 per cent iron. The hematite ore, mainly from the Clinton belt in central and western New York, averaged about 40 per cent in metallic iron.

Altogether there were 12 companies which reported an output last year, against 10 companies in 1908 and 13 in 1907. The new producers were the Salisbury Steel & Iron Co., at Salisbury Center, Herkimer co., and the Ontario Iron Ore Co., at Ontario Center, Wayne co.

The accompanying table gives the production of iron ore distributed according to kinds for the period 1890–1909 inclusive. The statistics covering the years previous to 1904 are taken from the annual volumes of the *Mineral Resources* published by the United States Geological Survey. The production of magnetite as given in the table represents high grade ore and concentrates ready for the furnace and not the mine output which is considerably larger.

Production of iron ore in New York State

YEAR	MAGNETITE	HEMATITE	LIMONITE	CARBONATE	TOTAL	Total value	Value per ton
	Long tons	Long tons	Long tons	Long tons	Long tons		
1890	945 071	196 035	30 968	81 319	1 253 393	....	.....
1891	782 729	153 723	53 152	27 612	1 017 216	....	.....
1892	648 564	124 800	53 694	64 041	891 099	$2 379 267	$2 67
1893	440 693	15 890	35 592	41 947	534 122	1 222 934	2 29
1894	....	....	....	....	242 759	....	.....
1895	260 139	6 769	26 462	13 886	307 256	598 313	1 95
1896	346 015	10 789	12 288	16 385	385 477	780 932	2 03
1897	296 722	7 664	20 059	11 280	335 725	642 838	1 91
1898	155 551	6 400	14 000	4 000	179 951	350 999	1 95
1899	344 159	45 503	31 975	22 153	443 790	1 241 985	2 80
1900	345 714	44 467	44 891	6 413	441 485	1 103 817	2 50
901	329 467	66 389	23 362	1 000	420 218	1 006 231	2 39
902	451 570	91 075	12 676	Nil	555 321	1 362 987	2 45
903	451 481	83 820	5 159	Nil	540 460	1 209 899	2 24
904	559 575	54 128	5 000	Nil	619 103	1 328 894	2 15
905	739 736	79 313	8 000	Nil	827 049	2 576 123	3 11
906	717 365	187 002	1 000	Nil	905 367	3 393 609	3 75
07	853 579	164 434	Nil	Nil	1 018 013	3 750 493	3 68
08	663 648	33 825	Nil	Nil	697 473	2 098 247	3 01
09	934 274	56 734	Nil	Nil	991 008	3 179 358	3 21

The list of active producers in 1909 included for the Adirondack region: Witherbee, Sherman & Co., and the Port Henry Iron Ore Co., at Mineville; the Cheever Iron Ore Co., Port Henry; the Chateaugay Ore & Iron Co., Lyon Mountain; the Benson Mines Co., Benson Mines; and the Salisbury Steel & Iron Co., Salisbury Center. The producers in southeastern New York were the Sterling Iron & Railway Co., Lakeville, and the Hudson Iron Co., Fort Montgomery.

The output of hematite was made by the Old Sterling Iron Co. with mines near Antwerp, Jefferson co.; Furnaceville Iron Co. and the Ontario Iron Ore Co., Ontario Center, Wayne co.; and C. A. Borst, Clinton, Oneida co.

Mineville. There was a good advance in the output of Mineville and if the demand for ore had been more active during the first part of the year the mines would have made a new record. The combined production of Witherbee, Sherman & Co., and the Port Henry Iron Ore Co. was 705,000 long tons, as compared with 502,663 tons in 1908 and 751,155 tons in 1907 which was the largest reported for any one year. The ore came from the Old Bed mines, including the Welch, "21," Joker and Bonanza workings, and the two Harmony shafts. The Barton hill mines of Witherbee, Sherman & Co. were under development but contributed no output. The new Clonan shaft which was started by the Port Henry Iron Ore Co., to tap "21" mine, was practically completed during the year, and should soon be in operation.

With a commendable policy of maintaining development and improvement work in advance of exploitation the Mineville companies have brought their mines and surface plants up to a high state of efficiency. The hoisting capacity is now well over 1,000,000 tons a year, which is larger than that of any other iron mining center in the east. From a technical point of view there are few iron mining localities anywhere of more interest than Mineville.

Among the improvements to the surface plants which have been underway during the year may be mentioned the new 800-ton mill, the third one to be constructed by Witherbee, Sherman & Co. This mill is situated between "A" and "B" shafts of the Harmony mines, the ore from which it is designed to treat. It is of fireproof construction, the materials being reinforced concrete and steel, and will cost $125,000 or more. The

plan of ore treatment will conform in general to that practised in the other mills, with such improvements as experience has suggested. The ore will undergo a preliminary crushing at the shaft houses and then be carried to a 1000-tone storage bin at the mill. After further reduction it will pass through Ball-Norton drum separators, then will be recrushed to ¼-inch size and separated on belt machines. The capacity of 800 tons in 10 hours for which the mill is designed will no doubt be considerably exceeded in practice. The development of the Harmony mines has yielded such favorable results that another mill was needed for handling their output.

The additional power required for the enlarged operations at Mineville has been provided for by the installation of a new 1500 kilowatt turbine engine at the Port Henry station. A low pressure turbine which uses the exhaust from a Corliss engine, has also been installed at the Mineville power house.

Some interesting developments have occurred in connection with recent explorations, through which additional light has been thrown upon the structure and geology of the ore bodies. The great Joker-Bonanza body has been shown to have quite different outlines on the southern section than had been anticipated, while another deposit apparently unconnected with it has been found in the footwall. These changes are indicated more definitely in a bulletin[1] recently issued by the State Museum.

A test hole put down in the old workings on Barton hill had reached (March 1910) a depth of about 1000 feet. The rock shown in the core belonged to the ordinary type that forms the walls of the principal ore bodies, with occasional bands of dark hornblendic gneiss. No gabbro was encountered in the section, though that rock occurs on the eastern slope of the hill. The ore-bearing gneiss thus continues without a break to a considerable depth below the point reached in the mine workings. Between the depths of 960 and 990 feet the rock was heavily charged with magnetite, but little ore was found.

Cheever mine. This, the oldest of the iron mines in the Port Henry district, has assumed new life after lying idle for many years. The ownership of the property, formerly held by O. S. Presbrey, who was instrumental in restoring it to activity, has

[1] Kemp & Ruedemann. Geology of the Elizabethtown and Port Henry Quadrangles. N. Y. State Mus. Bul. 138. 1910. p. 106 et seq.

been taken over by the Bethlehem Steel Co. and Witherbee, Sherman & Co., under the title of the Cheever Iron Ore Co. Many improvements to the mining and milling plants are now in progress.

The Weldon and French shafts on the south end are the principal openings through which the exploration of the old workings has been conducted. These shafts have been retimbered and inclosed and are once more in operation. They afford access to some promising territory. A good ore body has already been found on the north side of the Weldon, in the interval between that mine and the northern workings. This body supplies most of the output at present. It averages 8 or 9 feet thick and is of good grade. There is a possibility of discovering similar deposits under the valley to the south of the Weldon mine, as indicated by recent magnetic surveys. The northern workings also will be explored for ore that may have been left from previous operations.

An important improvement which is now being carried out is the change from steam to electric power for driving the mill and air compressors and for hoisting the ore. The necessary electric current is to be supplied by the Port Henry station. Under the new system both shafts will be operated from a central hoisting station. The compressed air service will be enlarged to provide for about double the former drill capacity.

The mill is equipped for handling 500 tons of crude ore a day. From the shafts the ore is carried by a gravity system to the receiving bin whence it passes through coarse crushers preliminary to the first separation. This is performed by a magnetic cobbing machine. The remainder is then recrushed by rolls and is run through the usual drum and belt machines, with a further crushing between the separations.

A gravity tramway connects the mines with the railroad at the lakeside, a few hundred feet to the east, where the concentrates are loaded onto cars for shipment.

Salisbury mine. The first shipments of concentrates from this mine, near Salisbury Center, Herkimer co., were made in 1909. The new mill was not completed, however, until late in the year, so that actual productive operations were limited to a short period. In the equipment of the mine and mill the Salisbury Steel & Iron Co. has adopted the most modern machinery suited for the conditions, and the results obtained

in the short run last year were reported to have been very satisfactory. A feature, novel to the Adirondack region, is the use of producer gas which is supplied by the company's plant; gas engines of 750 horsepower are installed and their power is transmitted to the mine and mill by electric current. The company operates its own branch railroad which connects with the New York Central lines at Dolgeville.

Lake Sanford. The development of the titaniferous deposits of this locality has been continued during the past year. Sanford hill has been largely cleared off and the ore exposed in several places. A few thousand tons of the ore were taken out and hauled by wagon to North Creek to be shipped for experimental purposes. Exploration with the diamond drill has been chiefly directed during the year to the Cheney deposits which lie to the west of Lake Sanford. The ore here occurs in gabbro and is mostly a fine grained mixture of magnetite and silicates; though in places it has a coarser texture like the usual grade of Sanford ore.

Sufficient work has been done to insure a large ore supply when mining is once started. Prominent metallurgists have expressed confidence that the magnetite can be reduced successfully in the blast furnace, at least when used in mixture with other ores, and offers have already been made for a large tonnage. Active operations can not be undertaken, however, until a railroad is constructed to the mines. The natural outlet, which is by the way of the Hudson river valley to North Creek, unfortunately seems to be blocked by the necessity of crossing State lands. The other alternative, to run the line east to some point on Lake Champlain, means the laying of from 50 to 60 miles of track over a rough country, whereas the distance to North Creek is only about 30 miles. It is hoped that a satisfactory solution of the difficulty may be reached, for the opening of the mines would give a great impetus to the iron ore industry of the State.

Clinton hematites. The production of ore along the Clinton belt was larger last year than in 1908, and it will probably show a further gain during the current year. In Wayne county the Ontario Iron Ore Co. started operations and the Wayne Iron Ore Co. made preparations for an active mining campaign at the opening of the present season. The Furnaceville Iron Co. contributed about the usual output from this region. At Clin-

ton, Oneida co., C. A. Borst has been the only active producer in the last few years.

Dutchess county limonites. According to current reports in the press, plans are under consideration for the reopening of the Kelly mine in the Salisbury limonite district. The Kelly Iron Ore Corporation is said to have taken a lease of this property which is situated in the town of Northeast near the Connecticut State line. The mine was last worked in 1888 as an open cut, but if the present plans are made effective it will be exploited hereafter by underground methods. It has convenient shipment facilities over both the New York Central and the New York, New Haven and Hartford lines.

It has also been reported that the Dover mine is under lease for the purpose of operation. This mine is situated in the town of Dover and at one time supplied ore to the Dover furnace.

The production of limonite in this region was once of considerable importance. After the year 1885, when the Lake Superior shipments began to develop rapidly, the output steadily diminished and one mine after another suspended work. The only mine which has been operated in recent years is the Amenia which was closed down in 1906. The prices of ore have since advanced to such an extent that the operation of the mines is again receiving consideration.

MILLSTONES

The production of millstones, although much smaller than formerly, is still an important industry in certain sections of Ulster county. This area furnishes nearly all of the millstones produced in the United States, the other producing states being Pennsylvania, Virginia and North Carolina. In addition to the domestic supply a large number of millstones and buhrstones are annually imported from France and other European countries.

The New York stone is known as Esopus stone, a name derived from a former name for Kingston, which was an important shipping point. It is a firm white conglomerate varying in fineness from that of a coarse sandstone to a coarse conglomerate with some pebbles 2 inches in diameter. It is composed of partially rounded whitish quartz pebbles in a silicious matrix. The stone is obtained from certain beds of Shawangunk grit, a rock lying unconformably upon the Hudson river shales and

formerly correlated with the Oneida conglomerate, but now known to lie in the horizon of the Salina. Its thickness varies from 50 to 200 feet.

The quarrying operations are carried on along the northern border of the Shawangunk mountains, in Rochester and Wawarsing townships, Ulster co., mainly along the line of the New York, Ontario and Western Railroad at Wawarsing, Kerhonkson, Accord, Kyserike, Granite, St Josen and Alligerville, while New Paltz and Kingston also are shipping points.

Quarrying is carried on with but a small equipment, the stone being worked out by hand bars, wedges and sometimes with the use of powder. It is dressed by hand at the quarry into millstones and chasers. The millstones are dressed into stones varying in diameter from 15 inches to 54 inches or even larger and are used for the grinding of paint, grain, cement, gypsum etc. The chasers are stones dressed to run on edge on a platform of blocks of the same material, and are used in grinding heavier material such as quartz, feldspar, barite etc. Depending largely on their weight for crushing the fragments, they are of large size varying usually in diameter from 54 to 72 inches.

The production of millstones has decreased very much in recent years owing to the introduction of roller mills in flour making, and ball mills, emery stones and other improved grinding machinery in other industries. The demand for millstones is now largely from corn-grinding mills in the south and from gypsum and plaster mills, while chasers are still used in quartz, feldspar and barite mills.

The value of the production of millstones and chasers and rough blocks used for paving chasers amounted last year to $19,247 as compared with a value of $18,341 in 1908. The selling prices of millstones in 1909 ranged from $3 to $4 for a 16 inch stone up to $60 for a 72 inch stone. Chasers in sizes from 54 to 72 inches sold at prices ranging from $30 to $70 each.

MINERAL PAINT

Under this title are included the natural mineral colors which require nothing more than washing or grinding in their preparation for the market. The raw materials found in the State that have been used for the purposes are iron ore, ocher, shale and slate. New York is also one of the leading producers of artificial pigments, specially those made from lead, but the crude materials are mostly derived from without the State.

The Clinton hematite affords an excellent base for the manufacture of metallic paint and mortar color. The beds with a relatively high iron content are employed, as they possess the softness and uniformity of texture, as well as depth of color, which are generally sought for. The mines owned by C. A. Borst at Clinton, Oneida co. and those of the Furnaceville Iron Co. at Ontario, Wayne co. supply most of the ore for paint. The hematite from the former locality belongs to the oölitic variety and that sold to paint manufacturers carries about 45 per cent iron. The ore in Wayne county is of fossil character carrying about 40 per cent iron. The red hematite from St Lawrence county is also used for metallic paint.

The manufacturers of metallic paint and mortar colors in New York State include the Clinton Metallic Paint Co. of Clinton, the William Connors Paint Manufacturing Co. of Troy, and the Rossie Iron Ore Paint Co. of Ogdensburg. A considerable quantity of the Clinton hematite is shipped to points outside of the State for manufacture.

Both shale and slate are ground for mineral paint, their color depending largely upon the amount and character of the iron oxids present. When there is a large proportion of ferric oxid the shale and slate may be sold as metallic paint. At Randolph, Cattaraugus co. beds of green, brown and bluish shale occurring in the Chemung formation have been worked by the Elko Paint Co. In years past red shale from the base of the Salina formation has been obtained in Herkimer county for paint. A similar material occurring in the Catskill series has been worked at Roxbury, Delaware co. The red slate of Washington county, which belongs to the Cambric, is also ground for paint. The Algonquin Red Slate Co. of Worcester, Mass. and A. J. Hurd of Eagle Bridge, are producers of this material.

A product known as mineral black has been made from the slates found in the Hudson River series. Certain beds contain considerable carbon in a finely divided almost graphitic condition which gives them a dense black color.

The ferruginous clay called ocher is of common occurrence, but is not now worked in the State. Sienna, a deep brown variety of ocher, is found near Whitehall.

The production of mineral paints in 1909 was as follows: metallic paint and mortar color 6560 short tons valued at $65,600; slate pigment 1155 short tons valued at $9130. In 1908

the following quantities were reported: metallic paint and mortar color 5750 short tons valued at $54,500; slate pigment 922 short tons valued at $7376. These quantities represent only the pigments manufactured within the State from local materials. In addition a large quantity of Clinton ore is shipped to other states each year for manufacture.

MINERAL WATERS

New York has held for a long time a leading position among the states in the utilization of mineral waters. The different springs, of which over 200 have been listed as productive at one time or another, yield a great variety of waters in respect to the character and amount of their dissolved solids. There are some that contain relatively large amounts of mineral ingredients and are specially valuable for medicinal purposes; Saratoga Springs, Ballston Springs, Richfield Springs, Sharon Springs and Lebanon Springs are among the more noted localities for such waters. Numerous other springs are more particularly adapted for table use, containing only sufficient mineral matter perhaps to give them a pleasantly saline taste. Both kinds of waters are generally carbonated and sold in small bottles.

Of late there has developed an important business in the sale of spring waters which can hardly be classed as mineral in the common acceptance of the word, but which are extensively consumed for office and family use in the larger towns and cities. Their employment depends upon their freedom from harmful impurities, in which feature they are generally superior to the local supplies. In so far as such waters are an article of commerce they may well be included in a canvass of the mineral water industry. They are distributed usually in large bottles or carboys in noncarbonated condition.

Character of mineral waters. Among the spring waters that contain mineral ingredients in appreciable quantity those characterized by the presence of alkalis and alkaline earths are the most abundant in the State. The dissolved bases may exist in association with chlorin and carbon dioxid, as is the case with the springs of Saratoga county, or they may be associated chiefly with sulfuric acid as illustrated by the Sharon and Clifton Springs.

NAME	LOCALITY
Redstone Spring	Oswego, Oswego co.
Mammoth Spring	North Greenbush, Rensselaer co
Shell Rock Spring	East Greenbush, Rensselaer co.
Massena Mineral Spring	Massena Springs, St Lawrence co.
Arondack Spring	Saratoga Springs, Saratoga co.
Artesian Lithia Spring	Ballston Springs, Saratoga co.
Chief Spring	Saratoga Springs, Saratoga co.
Congress Spring	Saratoga Springs, Saratoga co.
Geyser Spring	Saratoga Springs, Saratoga co.
Hathorn Spring	Saratoga Springs, Saratoga co.
Hides Franklin Spring	Ballston Springs, Saratoga co.
High Rock Spring	Saratoga Springs, Saratoga co.
C. N. Mead	Ballston Springs, Saratoga co.
Patterson Mineral Spring	Saratoga Springs, Saratoga co.
Royal Spring	Saratoga Springs, Saratoga co.
Saratoga Seltzer Spring	Saratoga Springs, Saratoga co.
Saratoga Carlsbad Spring	Saratoga Springs, Saratoga co.
Saratoga Emperor Spring	Saratoga Springs, Saratoga co.
Star Spring	Saratoga Springs, Saratoga co.
Washington Lithia Spring	Saratoga Springs, Saratoga co.
Chalybeate Spring	Sharon Springs, Schoharie co.
Eye Water Spring	Sharon Springs, Schoharie co.
Gardner White Sulphur Spring	Sharon Springs, Schoharie co.
Magnesia Spring	Sharon Springs, Schoharie co.
Red Jacket Spring	Seneca Falls, Seneca co.
H. W. Knight	Seneca Falls, Seneca co.
Pleasant Valley Mineral Spring	Rheims, Steuben co.
Setauket Spring	Setauket, Suffolk co.
Sparko Crystal Spring	Huntington, Suffolk co.
Elixir Spring	Clintondale, Ulster co.
Sun Ray Spring	Ellenville, Ulster co.
Vita Spring	Fort Edward, Washington co.
Briarcliff Table Water	Briarcliff Manor, Westchester co.
Gramatan Spring Water Co.	Bronxville, Westchester co.
Putnam Spring Water Co.	Peekskill, Westchester co.

Production. The canvass of the mineral springs for 1909 showed sales of 9,019,490 gallons with a reported value of $857,-342. In the preceding year the sales amounted to 8,007,092 gallons valued at $877,648. The number of springs reporting a production in each year was 48. The value of the waters is estimated at the spring localities and does not include the cost of bottling. No account is made of the waters used in hotels, sanatoriums etc., run in connection with the springs, though this is an important branch of the business in some places.

The above statistics should be considered only as approximations; the actual sales of waters doubtless exceed the reported quantities, since it is very difficult to obtain returns of all the trade. Some of the smaller producers keep no records of their business, and new springs, or those once abandoned, are constantly being utilized which may escape notice. The value of the annual sales of mineral waters very likely amounts to as much as $1,000,000.

The recovery of carbon dioxid from the wells at Saratoga Springs is the basis of an important industry that is carried on independently of the mineral water trade. The production of gas in recent years has averaged about 5,000,000 pounds valued approximately at $300,000. The gas is separated from the water at the well mouth and stored in tanks from which it is charged into cylinders under high pressure for shipment. The producers of gas include the Natural Carbonic Gas Co., New York Carbonic Gas Co., Lincoln Spring Co. and Geysers Natural Carbonic Gas Co.

Saratoga Springs. The need for conserving the mineral water supply at Saratoga has been brought to public attention recently, and the first steps to that end were taken last year through legislative enactment. It is aimed to place the spring properties under State supervision or control as a means of insuring against wasteful and injurious use on the part of private enterprise. A commission was appointed to investigate the situation at Saratoga and to take such action as might conduce to the restoration of the flow of the springs to their former strength and the maintenance of the future supply. The importance of adopting some plan for regulating the use of these valuable waters can scarcely be questioned, since it is well known that they are liable to deterioration and exhaustion in much the same way as other natural resources. Governmental control or ownership of mineral springs is a policy that has long been pursued by European states, with beneficial results.

NATURAL GAS

The productive gas fields of the State are distributed among 15 counties, of which Erie, Chautauqua and Allegany are the leading ones. The fields outside of the counties mentioned are scattered over the western section from Lake Ontario south to the Pennsylvania boundary. The most easterly localities where gas has been found in quantity are in Oswego county. Many wells have been drilled at different places in the eastern part of the State, particularly in the region south of the Mohawk river, but the exploration has been uniformly unsuccessful so far as locating any valuable pools.

According to the returns received for the year 1909, there were about 1250 wells in the State, the output of which was consumed for fuel and lighting purposes. No account was

taken of the wells that supplied gas for pumping operations in the oil districts. The number of individual producers was about 200, most of whom, however, made only a small output from one or two wells for their own supply. Aside from these minor enterprises, the industry was in the control of about 40 companies who distributed the gas for public use.

The surplus gas from the oil wells of Cattaraugus, Allegany and Steuben counties is collected mainly by the Empire Gas & Fuel Co., of Wellsville; the Producers Gas Co. of Olean and the United Natural Gas Co. of Oil City, Pa. The product is carried in pipe lines to Buffalo and other towns in the western part of the State. Buffalo is also supplied from the important fields in the eastern townships of Erie county, but elsewhere the supply is consumed mainly in the towns and villages that lie in proximity to the wells.

The quantity of gas produced in 1909 was approximately 3,825,215,000 cubic feet. To arrive at this total it was necessary to make estimates for some of the smaller producers who had no meters attached to their mains; but the proportion of the output involved in such estimates was inconsiderable. The reported value of the production was $1,045,693. This output of the wells was a little less than in 1908 when a total of 3,860,000,000 cubic feet was reported; but was larger than that for any year previous to 1908. Owing to a slight increase of prices — the average throughout the State having been 27 cents a thousand against 26 cents a thousand in 1908 — the value of the output was the largest on record.

The value of the production of natural gas during the past four years is shown in the accompanying table which is arranged to show also the contributions of the principal counties so far as practicable.

Production of natural gas

COUNTY	1906	1907	1908	1909
Allegany-Cattaraugus	$247 208	$250 159	$264 736	$282 964
Chautauqua	94 345	106 411	153 019	174 597
Erie*a*	317 554	320 199	451 869	461 531
Livingston*b*	52 805	55 780	54 083	59 888
Onondaga	16 385	17 030	13 837	12 310
Oswego	13 182	10 585	12 800	14 402
Wyoming*c*	25 100	39 850	37 431	40 001
Total	$756 579	$800 014	$987 775	$1 045 693

a Includes a part of the production of Genesee county.
b Includes also Seneca, Schuyler, Steuben, Ontario and Yates.
c Includes also Niagara and Genesee.

The record for the year shows less activity in the drilling of wells than usual, due perhaps to the unfavorable financial situation. The increment from new sources was insufficient to balance the natural decline in the output of the old wells, which has not occurred before in many years.

Among the notable developments of the year was the drilling of a deep well in northern Cattaraugus county which was reported to have encountered a pool in the Medina sandstone at a depth of 3300 feet. A 40 foot bed of rock salt was also penetrated. The well was located on the Sanders farm between Gowanda and Cattaraugus.

The South Shore Gas Co. completed a very successful well on the Griswold farm, near Forestville, Chautauqua co. The company has 32 wells, principally in the vicinity of Silver Creek and Dunkirk. The Frost Gas Co. added to its supply which is obtained from the towns of Sheridan and Pomfret. A new well in West Sheridan was reported to have shown a flow of 100,000 cubic feet a day.

A discovery of gas was made near Swain, in northeastern Allegany county, at a depth of 300 feet. The Burns Oil & Gas Co. put down a test well near Canaseraga which encountered a bed of rock salt at 3100 feet, but no gas in quantity.

The Allen-Salem Oil Co. completed a well on the Walker farm, 3 miles from Canisteo, Steuben co. Gas was found at a depth of 740 feet.

There was little change in the production of Erie county last year. The contribution from the fields, which are principally

in the eastern and southern parts, amounted to about 1,500,000,000 cubic feet or approximately 40 per cent of the total for the State. The wells in the eastern section are much the more important. They are largely controlled by the Akron Natural Gas Co., Alden-Batavia Natural Gas Co., Lancaster-Depew Natural Gas Co., Niagara Light, Heat & Power Co., and the United Natural Gas Co. In the southern part of the county the Springville Natural Gas Co. is the principal producer.

The Pavilion field of Genesee county, the most successful one that has recently been discovered in the State, made a good record in 1909. In all about 20 producing wells have been put down by the Pavilion and Alden-Batavia companies.

PETROLEUM

The oil district in the southwestern part of the State continues to afford a fairly large yield, though of course it has long since passed the high mark of productivity. The pools of Cattaraugus county were first tapped in 1865 and those in Allegany county about 1878, since which times they have been actively exploited. Many of the original wells that were drilled over 25 years ago still give a profitable return for pumping. No important discoveries have been reported in recent years, yet by redrilling of territory once abandoned as worthless and by gradually extending the bounds of the known pools the natural decline has been so checked that a long career of activity may be confidently expected for the future.

The productive area in Cattaraugus county is situated principally in Olean, Allegany and Carrolton townships, embracing about 40 square miles. The oil is found at depths ranging from 600 to 1800 feet. The larger pools are the Ricebrook, Chipmunk, Allegany and Flatstone. They occur in the Chemung formation of the Upper Devonic.

In Allegany county are the Bolivar, Richburg, Andover and Wirt pools which extend across the southern townships and are tapped by wells averaging from 1400 to 1800 feet deep. The Andover pool lies partly in the town of West Union, Steuben co. A recent estimate placed the number of productive wells in Allegany county at 6000.

The discovery of a new pool in northern Allegany county a few years ago aroused unusual interest in that it indicated a much wider range of the oil-bearing strata than had previously

been thought possible. The locality is in the town of Granger, on the Livingston county border. About 30 wells were put down, some of which flowed at first under natural pressure. They soon gave out, however, and the entire yield amounted to less than 3000 barrels. During the past year the exploration of another section in the northern part of the county was started by the drilling of a well near Swain, Grove township. The first well was put down on the Fred Bennet farm; a heavy pressure of gas was encountered at 700 feet and a flow of oil at 740 feet. A second well 400 feet from the first was immediately drilled to the same depth but proved to be dry. The value of the discovery can not be determined until further tests are made.

A test well at Canaseraga in the town of Burns, Allegany co., was drilled to a depth of 3200 feet. The record as reported in the *Petroleum Gazette* (July 1909) gave the occurrence of a small quantity of oil and gas at 275 feet in gray sand. Another streak of gas sand was struck at 400 feet. At 975 feet the drill tapped a 12-foot seam of chocolate sand with a light showing of oil and gas. From 975 feet to 2650 feet the strata were chiefly black and brown shales. At 2650 feet the drill entered limestone which was very hard and may have been the Onondaga; at least it was not the Niagara limestone as stated in the record. At 3050 feet the drill passed through 65 feet of clean unbroken salt. A blue shale was found at 3115 feet which continued to the bottom of the well at 3200 feet.

The production of petroleum in 1909 amounted to 1,160,402 barrels, or almost the same as in 1908 when it was 1,160,128 barrels. The value of the output was a little lower than in the preceding year due to a drop in the prices which fell off from $1.78 a barrel in the early months to $1.43 a barrel in December. The accompanying table gives the production and its value for each year since 1891. The statistics for 1904 and subsequent years have been compiled from pipe line receipts reported to this office by the companies who handle the output. The earlier statistics are taken from the volumes of the *Mineral Resources*. The following companies have pipe lines in the district: The Allegany Pipe Line Co., Columbia Pipe Line Co., Union Pipe Line Co., and Fords Brook Pipe Line Co., all of Wellsville; Vacuum Oil Co. of Rochester; New York Transit Co. of Olean; Emery Pipe Line Co., Kendall Refining Co., and Tide Water Pipe Co., Limited, of Bradford, Pa.

a Production of petroleum in New York

YEAR	BARRELS	VALUE
1891	1 585 030	$1 061 970
1892	1 273 343	708 297
1893	1 031 391	660 000
1894	942 431	790 464
1895	912 948	1 240 468
1896	1 205 220	1 420 653
1897	1 279 155	1 005 736
1898	1 205 250	1 098 284
1899	1 320 909	1 708 926
1900	1 300 925	1 759 501
1901	1 206 618	1 460 008
1902	1 119 730	1 530 852
1903	1 162 978	1 849 135
1904	1 036 179	1 709 770
1905	949 511	1 566 931
1906	1 043 088	1 721 095
1907	1 052 324	1 736 335
1908	1 160 128	2 071 533
1909	1 160 402	1 914 663

a The statistics for the years 1891–1903 inclusive are taken from the annual volumes of the *Mineral Resources*.

The records of new wells as compiled and published by the *Oil City Derrick* show that a total of 457 wells were completed in New York during 1909. The increment from the new wells amounted to 715 barrels a day. Of the number 32 were dry holes. In 1908 the corresponding totals were 450 new wells including 60 dry ones, with a daily production of 750 barrels.

PYRITE

Pyrite is a common ingredient of the metamorphosed sedimentary rocks which are found in the Highlands of southeastern New York and in the Adirondacks. It occurs disseminated in the crystalline limestones and schists and occasionally forms bands and lenticular masses of variable size and purity within the schists. In character these deposits are very similar to the magnetite bodies that are found within the altered sediments of both regions, and in fact the two minerals are frequently associated in their occurrence. On the other hand the magnetites that are contained in the acidic gneisses of igneous origin generally carry little or no pyrite. Pyrrhotite is

a common associate of the pyrite, and zinc blende and chalcopyrite may be usually observed in small amount. Large bodies of nearly pure pyrrhotite occur in the Adirondacks, but as they can not be utilized for their sulfur and carry only traces of nickel they have no commercial value.

In southeastern New York there are no active pyrite mines, though a deposit at Anthony's Nose, above Peekskill, was worked some 30 or 40 years ago as a source of ore for sulfuric acid manufacture. The ore appears to have carried considerable pyrrhotite and would not be considered mineable at the present day.

The principal deposits of pyrite in the Adirondack region are found along a belt of crystalline limestones and schists that extend from near Antwerp, Jefferson co., into the town of Canton, St Lawrence co. They take the form of impregnated zones, or fahlbands, the pyrite being intermixed with the minerals of the schistose country rock, which are chiefly quartz, feldspar and hornblende; some deposits have a pronounced lenticular shape, with the longer axis of the lenses parallel to the foliation of the schists. The pyrite occurs in crystals and crystalline aggregates of variable purity. The associated silicates are generally more or less decomposed. The surface portion of the deposits has the characteristic reddish stain and burnt look due to oxidation, though the weathered zone is remarkably shallow, the fresh pyrite being found usually within a few feet from the surface.

There are a number of mines and prospects in this region, but at present active mining is carried on only by the St Lawrence Pyrite Co., at Stellaville, near Hermon. The properties owned by the company include the Stella mines, which it took over in 1905, and other holdings in the vicinity that have been subsequently acquired. Most of the ore is of concentrating grade and is treated in a 500-ton mill equipped with Hancock jigs, Hartz jigs and Overstrom tables. The concentrates carry from 40 to 48 per cent sulfur. Electric current for power purposes is supplied from a central station at Hannawa Falls.

The mines at High Falls which were taken over a few years ago by the Oliver Mining Co. have not been placed in operation as yet, though the exploration by the diamond drill, which the company carried out, is reported to have shown very favorable results. The mines were once worked by the High Falls Pyrite Co., and later by the National Pyrites Co.

SALT

The canvass of the salt industry for 1909 indicated very little change in trade conditions from those reported for the preceding year. The only direction in which the trade may be said to have evidenced an improvement was in a larger consumption of certain grades of salt and a corresponding gain of output. The prices generally showed no response to the increased demand; in fact their average for the year was somewhat lower than in 1908 when the market felt the full effects of the financial stringency.

Keen competition with the industry of other states has tended of late years to reduce prices and to restrict the outlet for the local product. The manufacture of evaporated salt has developed rapidly in Michigan, Ohio and Kansas, under the influence of cheap fuel, which now supply the markets of the Middle West. In New York, New England and some of the adjoining territory, the local manufacturers still have the advantage, owing to more favorable freight rates. Along the seaboard, however, there is considerable competition with imported salt which comes chiefly from the Mediterranean countries and the West Indies. The importation is likely to increase in the immediate future by reason of a reduction in the duty of 20 cents a short ton on all grades of salt, that was incorporated in the Payne tariff bill.

The total quantity of salt obtained from the New York mines and wells last year was 9,880,618 barrels of 280 pounds. This may be considered a very satisfactory showing, as the output for 1908 amounted to 9,005,311 barrels and that for 1907, which was the largest previously reported for any one year, amounted to 9,657,543 barrels. The increase in production was thus 875,307 barrels or nearly 10 per cent, as compared with a decrease of 652,232 barrels or 7 per cent in the preceding year. The total value of the yield was $2,298,652 against $2,136,736 in 1908 and $2,449,178 in 1907, or an average of 23.3 cents a barrel against 23.7 cents in 1908 and 25 cents in 1907.

Converted to a tonnage basis the production last year amounted to 1,383,386.5 short tons against 1,260,743.5 short tons in the preceding year.

The gain was distributed between the output of rock and brine salt, both classes showing about the same proportionate increase.

It is to be noted that not all of the salt reported as above was actually marketed in that form. A very considerable part of the brine pumped from the wells each year is employed without evaporation for the manufacture of soda products. The Solvay Process Co., the principal manufacturer of such products in this country, has a number of wells in the town of Tully, Onondaga co., which supply brine to its works near Syracuse. The salt contents of this brine are included in the production. The small valuation placed upon the salt thus used reduces the average well below the actual value of the marketable product.

There were about 30 mines and works which contributed to the production last year, as compared with 32 in 1908 and 33 in 1907. Onondaga county alone was represented by more than one half of the number. The manufacture of salt by the solar process has long been centered in that county where it is carried on by individuals and companies operating in a relatively small way. The output has been marketed for many years through the Onondaga Coarse Salt Association. The operative plants in the other counties were distributed as follows: Livingston 3; Schuyler 2; Tompkins 3; and Wyoming 3. The International Salt Co., the largest producer of evaporated salt in the State, maintained three plants in operation, one each at Ithaca, Myers and Watkins. No new firms were added to the list of producers during the year.

The accompanying tables furnish details as to the production of salt in New York. In the tables for the years 1908 and 1909 the output is distributed among the several grades recognized in the trade. The classification is based upon methods of manufacture and purposes for which the salt is used. Table and dairy salt includes the finest grades of artificially evaporated salt, specially prepared for the table and for butter and cheese making; it brings the highest market price. Under common fine, is listed the other grades of fine, artificially evaporated salt that are not specially prepared. Common coarse represents the coarser product from artificial evaporation. Coarse solar salt is made by evaporation of brine in shallow pans exposed to the sun's heat. This process, as already stated, is used by manufacturers in Onondaga county; it can be carried on, of course, only during the summer months. Packers salt includes the product sold to meat packers and fish salters. Under "other

grades " are listed agricultural salt and other kinds not specified in the returns from producers, as well as the entire product of rock salt and of salt in brine used for the manufacture of soda products. These latter items form a very important part of the total. As will be observed the salt thus listed bears a much smaller valuation per barrel than the grades first mentioned.

Production of salt by grades in 1908

GRADE	BARRELS	VALUE	VALUE PER BARREL
Common fine*a*	941 682	$372 485	$ .39
Common coarse	194 593	72 427	.37
Table and dairy	1 188 636	631 987	.53
Coarse solar	520 607	117 136	.22
Packers	36 114	14 515	.40
Other grades*b*	6 123 679	928 186	.15
Total	9 005 311	$2 136 736	$ .237

a Common fine includes a small amount of common coarse.
b Include rock salt, salt in brine used for soda manufacture, and small amounts of brine salt for which the uses were not specified in the returns.

Production of salt by grades in 1909

GRADE	BARRELS	VALUE	VALUE PER BARREL
Common fine*a*	1 436 233	$494 464	$ .35
Common coarse	130 200	45 569	.35
Table and dairy	1 281 207	633 195	.50
Coarse solar	540 614	162 253	.30
Packers	99 123	38 344	.40
Other grades*b*	6 393 241	924 877	.14
Total	9 880 618	$2 298 652	$ .233

a Common fine includes a small amount of common coarse.
b Include rock salt, salt in brine used for soda manufacture, and small amounts of brine salt for which the uses were not specified in the returns.

The distribution of the salt made this year, according to counties, shows that Livingston held first place in size of output, having superseded Onondaga county which was formerly the largest producer. The importance of the industry in Liv-

ingston county was due principally to the activity in rock salt mining at Retsof and Cuylerville. The Retsof Mining Co. and the Sterling Salt Co. furnished the output. The Genesee Salt Co. was the only producer of brine salt in the county.

Onondaga county was second in regard to production, though the greater part consisted of salt in brine consumed by the Solvay Process Co.

Tompkins county, represented by the International Salt Co., with two plants, and the Remington Salt Co., made the third largest output. Wyoming county with the three plants of the Worcester Salt Co., the Iroquois Salt Co., and the Rock Glen Salt Co., was fourth in the list, followed by Schuyler county with two plants owned by the International Salt Co., and the Watkins Salt Co.

The progress of the salt industry in New York during the last 25 years is summarized in the table below. The statistics for the years previous to 1904 have been extracted from the annual volumes of the *Mineral Resources.*

Production of salt in New York since 1885

YEAR	BARRELS	VALUE
1885	2 304 787	$874 258
1886	2 431 563	1 243 721
1887	2 353 560	936 894
1888	2 318 483	1 130 409
1889	2 273 007	1 136 503
1890	2 532 036	1 266 018
1891	2 839 544	1 340 036
1892	3 472 073	1 662 816
1893	5 662 074	1 870 084
1894	6 270 588	1 999 146
1895	6 832 331	1 943 398
1896	6 069 040	1 896 681
1897	6 805 854	1 948 759
1898	6 791 798	2 369 323
1899	7 489 105	2 540 426
1900	7 897 071	2 171 418
1901	7 286 320	2 089 834
1902	8 523 389	1 938 539
1903	8 170 648	2 007 807
1904	8 724 768	2 102 748
1905	8 575 649	2 303 067
1906	9 013 993	2 131 650
1907	9 657 543	2 449 178
1908	9 005 311	2 136 736
1909	9 880 618	2 298 652

SAND

The production of sand for its varied uses in engineering and building work, metallurgy etc., is carried on extensively in New York and most requirements of the different industries are or can be supplied by the local deposits. Considerable quantities of the more valuable molding sands are shipped to other states.

A brief account of the several branches of the sand industry was given in the issue of this report for 1908. According to the statistical canvass which was undertaken in connection with the report, the value of the production amounted to $1,130,291. This total should be considered, however, an approximation only; the actual output probably was considerably larger, as productive operations, specially in building sands, are so widely scattered and of so unstable character that no doubt many escaped enumeration. In the present report attention will be limited to the molding sand trade.

Molding sand. The use of sand in the casting of metals calls for a large supply of special grades which have a rather limited distribution, as compared with building sands, and are consequently more valuable.

In New York State there are two main areas in which good molding sand beds abound: (1) on the lands bordering the Hudson river from Orange county northward on both sides of the river, to Saratoga county; (2) in Erie county. The sand is found in shallow beds immediately underlying the sod and often covering many acres. Beds 8 inches or more in thickness are worked profitably, a 1-foot bed over one acre yielding about 1200 tons. The large increase in business in the iron and steel plants was directly responsible for an increase in the production of molding sand. The production in 1909 amounted to 468,609 short tons valued at $437,402, as against 312,819 tons valued at $277,290 in 1908. Notwithstanding the increase, however, the production fell far short of that reported in 1907 of 693,293 tons valued at $539,674, which would indicate that the foundries had not fully recovered from the panic conditions prevailing in 1908.

Of the total production the Hudson river region furnished 450,989 tons valued at $422,144 or about 96 per cent of the total. The remainder of the production was obtained mainly from Erie county.

The silica sand used in connection with the molding sand for the cores of the castings and known as core sand is obtained mainly around Oneida lake in Oneida county. Its production naturally increased also in 1909, the total being 30,230 tons valued at $25,472, against 27,624 tons valued at $22,371 in 1908.

SAND-LIME BRICK

The manufacture of sand-lime brick showed a marked increase during 1909, resulting in a production greatly in advance of that of 1908, though not equalling the output for 1907. The total production amounted to 12,683,375 brick valued at $81,693 as against 8,239,450 brick valued at $55,688 in 1908. The average value at the yard for the common brick in 1909 was $6.31 a thousand.

There were six companies who reported an output last year, as follows:

NAME	LOCATION
Buffalo Sandstone Brick Co.	Buffalo
Rochester Composite Brick Co.	Rochester
Paragon Plaster Co.	Syracuse..
Sandstone Brick Co.	Schenectady
Schenectady Brick Co.	Schenectady
Granite Brick Co.	Glens Falls

The Grant Brick Co. of Brooklyn and the Dyett Sand-Lime Brick Co., with a plant at Port Jefferson, are expected to begin operations during the present season.

Owing to the abundance of good brick clays in the State, specially along the Hudson river, the sand-lime brick industry is making no great progress, as compared with its growth in some parts of the country. There seems no reason, however, why the industry should not supply the local demand for the material, since there are large quantities of sand and limestone adapted to the purpose.

In a paper by S. V. Peppel [Geological Survey of Ohio, Bulletin 5] it is stated that the sand used for brick should show not over 10 per cent clayey impurities and should pass through a 20-mesh sieve. The lime may be high calcium or magnesian, but the former is preferred. The process consists of mixing the hydrated lime with the sand, pressing the brick, and subjecting them to a steam pressure of 120 pounds or so in a strong cylinder for 10 hours. This cooking transforms some of the ma-

terial into a hard, hydrous silicate of lime, which binds the sand grains together. The amount of lime used varies from 5 to 20 per cent depending on the purity of the sand.

Although several patented systems of manufacture are on the market, the general scheme is not patented and the manufacture of the brick can be undertaken by any one. In fact several American companies have recently entered the field with their own systems and no patents.

The estimated cost of a well equipped plant with a capacity of 20,000 brick, per 10 to 12 hours, is estimated by Mr Peppel to range, in Ohio, independent of site and buildings, from $20,000 to $25,000.

The cost of production in the United States, exclusive of depreciation in plant, interest on investment, loss of time in breakdown and repairs, etc., according to the same author, varies from $3 to $4 per 1000. The selling price ranges from $8 to $15 per 1000.

From a large series of tests made, Peppel considers sand-lime brick to be strong and durable and in all respects a safe and reliable building material.

SLATE

BY HENRY LEIGHTON

The slate belt of New York State occupies an area extending from the Poultney river, the northern boundary of Washington county, south to the Batten kill, and from the Vermont border west a distance varying from 6 miles in the northern to 12 miles in the southern portion. The majority of the active quarries are in the central part of the field, in Granville township. Under a slight covering of glacial drift and soil, the rocks of the belt consist of a series of Cambric and Ordovicic sediments, greatly metamorphosed and intricately folded. They are made up of limestone, shale, slate, quartzite and sandstone members, with slate predominating. The original bedding of the slates has been partially obliterated by the metamorphism and in its stead a pronounced cleavage has been developed. The dip of the cleavage planes is very steep, usually 45° or more. The original bedding planes can often be distinguished in the slates as bands or ribbons of varying color.

The slates vary in color, red, purple, mottled and green slates being found in the belt. Of these the red is the most valuable,

while a quality of green slate known as the unfading green is also quarried to a large extent.

The slate is taken out from large open pits or quarries, the face afforded by a side hill being often utilized. The blocks are loosened by blasting and by the use of bars, etc. Hoisting is effected by means of a traveler carrying a small hoisting cable and running on a larger wire cable strung across the pit. This cable is anchored on one side of the pit and passes over a tall mast on the other, giving an inclined cableway on which the traveler may run. The whole is operated by a small drum hoist which allows the traveler to run out to any position desired over the pit. It is then automatically locked to the cable and the smaller hoisting cable descends from it into the pit to receive its load. The block of slate is hooked to the cable, hoisted to the traveler and by it is carried directly to the trimming sheds or is loaded on cars which are pushed to the sheds. The waste rock, which must be hoisted as well, is dumped in huge conical piles around the mast.

For the manufacture of roofing slate, which is the main use of the slate, the blocks are carried into small sheds, often perched on the dump piles. These sheds are equipped with a trimmer, a few mallets and chisels and some shelving. Two men work in each shed. The block, usually from 4 to 6 inches thick, is turned on edge and carefully split with chisel and mallet into sheets from 1/8 to 1/2 inch thickness. The sheets thus formed are then squared up into rectangular roofing slates. The trimmer used for this purpose consists of two blades resembling lawn mower knives, a heavy fly wheel for giving sufficient momentum, a stationary straight edge beneath the knives, a feeding plate and a treadle to set the knives in motion. The slate is fed under the revolving knives and is thus sheared off an inch or so at a time until trimmed to the proper size. The larger slates bring the better prices and some skill is needed in the splitting and trimming. The men employed are paid either by the hour or by the square.

The slate used for billiard table tops, electrical switchboards, stair treads, and other purposes where slabs are required, is known as mill stock. For these purposes, certain beds only are suitable, and quarrying is conducted in the same manner as for roofing slate. The blocks are then dressed in mills where they are first sawed by circular toothed saws and then planed smooth on a planer and polished or rubbed on a rubbing table. The

saw is operated much in the same manner as a circular saw for sawing wood. The planer consists of a heavy steel blade about 8 inches wide mounted so as to remain stationary while the slab of slate passes under it on a sliding table. By setting the blade at the proper distance the slab can be trimmed and smoothed down to a level surface.

The most striking feature that is presented to a visitor in the slate region is perhaps the enormous piles of waste material. The waste in slate quarrying exceeds that from the quarrying of any other material, the dump often claiming 60 per cent of the total slate quarried. Some of the waste slate is ground and utilized in making paints and pigments while attempts at its utilization in cement and brick making have been made.

The quarries at present active are all located in a belt paralleling the Delaware & Hudson Railroad from northern Hebron township through Granville township to southern Hampton township. The following quarries were in operation during 1909, listed in order from the southern end of the belt, with location and product.

Mathews Slate Co., 1½ miles south-southwest of West Pawlet and ½ mile west of Vermont line; product, red roofing slate.

Nelson & Guthrie, 1½ miles west of West Pawlet, on line between Hebron-Granville townships; red roofing slate.

Granville Slate Co., 1 mile south-southwest of Granville just west of Vermont line; green roofing slate.

Higrade Slate Co., 1½ miles south of Granville; red roofing slate.

Excelsior Red Slate Co., 1 mile south southwest of Granville Railway station, on hillside west of Indian river; red roofing slate.

Beck Slate Co., just north of the Excelsior quarry; red roofing slate.

Enterprise Slate Co., ¾ of a mile south of Middle Granville, west of the Mettawee river; green roofing slate.

Williams Bros., ¾ of a mile north of Middle Granville on main road; green roofing and mill stock.

Prairie Slate Co., adjoining Williams Bros., on north; green roofing slate.

Ferndale Slate Co., 2½ miles north-northeast of Truthville; green roofing slate.

Mathews Slate Co., 3 miles north of Truthville in Whitehall township; green roofing slate.

Mathews Slate Co., Jamesville, ½ mile from railroad switch; green roofing slate.

New York Purple Slate Co., near Hampton; purple roofing slate.

The finished slate is all shipped by rail on the Delaware & Hudson Railroad. Some of the quarries are connected by switch with the main track, but in most instances the slate is hauled from ½ to 3 miles to the loading point. One quarry on the Vermont side of the line, transports the finished slate to Raceville by means of an aerial wire rope tramway, the buckets carrying the roofing slate to the shipping point and carrying coal back to the quarries.

The plants for the dressing of mill stock are all located in Vermont, the plant of the Mathews Slate Co. being situated almost on the line, near Jamesville. It is equipped with saws, planers, rubbing table and drills. The finished stock is hauled a short distance to the Jamesville switch for shipment.

Slate quarrying is a financially precarious undertaking. Often large amounts of money have been expended in the region with no return whatever, and this is evidenced by the abandoned prospects scattered over all the hills. The surface soil and glacial drift must first be removed and then the slate quarried out to some depth before any idea can be had concerning the character of the vein, all of which is costly. Even though a good seam or vein is found, it may, after a short quarrying season, become worked out and useless and the quarry must be abandoned. The best veins can be worked down along the dip only for a short distance on account of the overburden and the quarry must in time be extended along the strike, as is often done in the larger operations, or a new pit opened up. All of these factors, in addition to the large amounts of waste rock necessarily quarried and disposed of, combine to lower the profits or even bankrupt the operator. For this reason the opening of a quarry should be undertaken only under the supervision of a man of long experience and only by one with a large amount of capital for preliminary work.

Though quarrying operations are carried on the year round, working days are limited. Severe winter weather causes the quarries to close, while in wet weather at any time of the year it is impossible to have many men at work in the quarries. The treacherous slipping of the steeply inclined strata is the cause

of many serious accidents and during rainy weather the quarries must work short-handed.

The output of slate in the State increases and decreases irregularly from year to year, no very great change in the production having taken place in years. The use of various kinds of patent roofing papers, tars etc., has had a tendency to lower the demand for roofing slate, while on the other hand the increasing high price and scarcity of wooden shingles has increased the demand for other roofing materials. The fact that New York State produces such handsome red slates, which are obtained at but few other localities, causes a heavy demand for this grade and the price remains high. The supply of good red slate, however, is limited.

The year 1909 seems to have been an exceptionally brisk year among the quarries, and the production reached a figure exceeding any preceding year. The total value of the output was $127,050 against $111,217 in 1908 and $54,800 in 1907. The only other year showing an output of over $100,000 was 1903 when the value reached $111,998. The output consists mainly of roofing slates, of which there were produced 21,187 squares valued at $126,170, an average value per square of $6.99 against $8.09 in 1908. The high value as compared with the average value for other slate regions is due to the output of red slate which commands a value of $8 to $10 a square. About 11 per cent of the roofing slate made was of red or variegated color, the remainder of green.

The balance of the slate output was made up of mill stock, both red and green, with a total output of 8000 square feet valued at $880.

STONE

BY HENRY LEIGHTON

The quarrying of stone and its preparation for the market continue to hold a place among the most important of the mineral industries of the State. Although cement and concrete have to some degree supplanted cut building stone in constructional work, the use of the former materials has created an ever-increasing demand for crushed stone and rubble. A large amount of this crushed stone and in many cases the supply of building stone is now produced by large companies operating small areas intensively. Improvements in quarrying, drilling, crushing and transportation machinery have contributed largely to the increasing production of stone.

The State is well supplied with the various kinds of stone and in the extensively developed areas there are exceptionally good transportation facilities. The proximity of the Palisades to New York city and excellent shipping facilities have contributed toward the development of the trap quarries; the marble quarries of Dutchess county are likewise well situated; while the Onondaga limestones form a convenient escarpment but a short distance from Buffalo in the western part of the State.

The advance in the production of stone over 1908 was marked. The total production of stone in 1909 was $7,061,580, an advance over the production of 1908 which was $6,615,614, of 6 per cent. The advance, however, seems to have been restricted to but two classes of products: crushed stone and the miscellaneous uses such as lime, rubble etc. The crushed stone output advanced from $2,659,016 to $3,214,374 an increase of 20 per cent. The increase in the column headed " all others " was due to the large output of rubble and riprap, the increase in lime production and in the sandstone output, and to a transposition of some values in former years included with the building stone. A notable reduction in output was found in the stone used for building stone and curbing and flagging. The output of the former amounted to $873,651 in 1909 against $1,264,403 in 1908, while curbing and flagging was produced to the value of $800,620 against $928,511 in 1908.

All kinds of stone showed an increased output over 1908 with the exception of marble, the output of which fell from $692,857 in 1908, to $380,016 in 1909.

Trap rock showed the greatest increase in output rising from $723,773 in 1908 to $1,061,428 in 1909 or a gain of 46 per cent.

Production of stone in 1907

VARIETY	BUILDING STONE	MONUMENTAL	CURBING AND FLAGGING	CRUSHED STONE	ALL OTHER	TOTAL VALUE
Granite	$84 774	$9 613	*a*	$92 950	$8 563	$195 900
Limestone	189 782	....	$13 123	1 725 203	1 254 339	3 182 447
Marble	1 408 190	152 746	*a*	*b*	11 000	1 571 936
Sandstone	525 799	....	1 051 070	55 818	305 730	1 998 417
Trap	*a*	....	....	939 027	2 000	941 627
Total	$2 208 545	$162 359	$1 064 193	$2 812 998	$1 642 232	$7 890 327

a Included under "All other." *b* Included under " Limestone."

Production of stone in 1908

VARIETY	BUILDING STONE	MONUMENTAL	CURBING AND FLAGGING	CRUSHED STONE	ALL OTHER	TOTAL VALUE
Granite	$71 122	$27 585	a	$152 783	$116 074	$367 564
Limestone	245 655	....	$15 668	1 647 629	1 210 883	3 119 835
Marble	567 444	111 492	....	....	13 921	692 857
Sandstone	380 182	....	912 843	135 741	282 819	1 711 585
Trap	....	....	....	722 863	910	723 773
Total	$1 264 403	$139 077	$928 511	$2 659 016	$1 624 607	$6 615 614

a Included under "All other."

Production of stone in 1909

VARIETY	BUILDING STONE	MONUMENTAL	CURBING AND FLAGGING	CRUSHED STONE	ALL OTHER	TOTAL VALUE
Granite	$35 019	$33 818	$1 352	$182 029	$227 737	$479 955
Limestone	217 109	....	15 363	1 744 314	1 323 597	3 300 383
Marble	262 934	104 495	25	6 403	6 159	380 016
Sandstone	358 589	....	783 880	220 200	477 129	1 839 798
Trap	....	....	....	1 061 428	....	1 061 428
Total	$873 651	$138 313	$800 620	$3 214 374	$2 034 622	$7 061 580

Granite

The granites of the State are confined to the borders of the Adirondack region including Jefferson county and to southeastern New York. Many of them are durable and take a beautiful polish but they have never succeeded in competing as cut stone with the granite of the New England States. The causes assigned are various; less favorable facilities for transportation, irregularity of the deposits, and lack of a "name" or prestige are all in part responsible. Two promising fields for larger development of dressed building and monumental stone are the Pictou and Wellesley island area in the St Lawrence river, and the Ausable Forks quarries in Essex county. At the former locality large quantities of stone are being cut for paving blocks, while its use in polished form bids fair to become more popular.

The Ausable Forks granite has been quarried intermittently for many years. In recent years, however, the operations have been increased under the management of the Ausable Forks Granite Co., and in 1909 a large production of rough monumental and building stone was made. This stone is of somber green color, takes a handsome polish and is excellent for monumental and building purposes.

At Little Falls, Herkimer co., where an outlying tongue of syenite is quarried and crushed, three firms were in operation. The output is mainly sold as crushed stone for road and concrete work. The centralized location and good transportation facilities have given rise to a large industry. The plant of the Syenite Trap Rock Co. was destroyed by fire in November but will in all probability be rebuilt.

The industry in Westchester county remains in about the same condition as in previous years. The granite and gneiss of the county are quarried in a small way, and used locally, or shipped to New York. The gneissic character of the stone makes it of use, mainly, for building purposes, especially for foundation work. Some of the granite when polished, however, presents a pleasing appearance. Eight firms were operative in the county in 1909. Many Italians work quarries in an intermittent way, merely skimming off the top rock from place to place. This class of production must be omitted from the tabulations as it is impossble to collect accurate statistics.

One of the features of the year was the opening of a quarry at Cornwall, Orange co., by the Storm King Stone Co. which produced a large quantity of crushed stone.

Clinton, Fulton and Rockland counties also contributed to the production in 1909.

The total production for the year was $479,955 as against $367,564 for 1908, a gain of 30 per cent. This gain was almost entirely due to the enormous gain in output of paving blocks in Jefferson county and to the output from Orange county. The paving block industry made a very encouraging advance, the production in 1909 being more than double that of 1908. The stone for building purposes showed a decided decline in production over the year 1908. The production of building stone in 1909 was valued at $35,019 against $71,122 in 1908. Monumental stone, on the other hand, because of the activity at Ausable Forks gained slightly, the value for 1909 being $33,818 against $27,585 in 1908.

The crushed stone industry received a slight setback because of business troubles at Little Falls, but this was offset by the production of the two new firms in Orange and Rockland counties. The total production in 1909 reached $182,029 as against $152,783 in 1908.

Production of granite

	1907	1908	1909
Building stone	$84 774	$71 122	$35 019
Monumental	9 613	27 585	33 818
Crushed stone	92 950	152 783	182 029
Rubble, riprap	5 600	15 351	12 737
Other kinds[a]	2 963	100 723	216 352
Total	$195 900	$367 564	$479 955

[a] Includes in 1908 curbing, paving blocks, and minor uses.

Limestone

New York State is abundantly supplied with limestone. In the western and central parts of the State are the Onondaga and Niagara formations; in the northern section the crystalline limestones of St Lawrence county; in the east the Helderberg limestones; and in the southeast various crystalline limestones. These vary greatly in purity and this variation makes it possible to obtain a stone suitable for almost any purpose.

The stone discussed under this heading, with the exception of some crystalline limestone used for flux or lime making, is all of a noncrystalline, massive character. The stone used so extensively in portland cement manufacture is not included in the tabulations.

The total production of limestone for 1909, exclusive of that used in cement manufacture was valued at $3,300,383, a slight gain over the value for 1908 which was $3,119,835.

Among the counties Erie showed the largest production with a total of $853,764, a large increase over the production of last year. It was followed in descending order by Dutchess, Onondaga, Genesee and Jefferson counties, all of which showed large gains with the exception of Onondaga, whose production took a decided drop.

The production was distributed among the various products as follows: crushed stone $1,744,314; building stone $217,109; lime $452,874; furnace flux $434,311; other uses $451,775. All of these took part in the general increase in production but the stone used for building purposes which fell from $245,655 in 1908 to $217,109 in 1909. The lime made in connection with the products of the Solvay Process Co. and the Union Carbide Co. is included under "other uses."

Production of limestone

MATERIAL	1907	1908	1909
Crushed stone	$1 725 203	$1 647 629	$1 744 314
Lime made	*a*888 309	401 728	452 874
Building stone	189 782	245 655	217 109
Furnace flux	338 127	230 117	434 311
Rubble, riprap	14 588	*c*.........	82 748
Flagging, curbing	13 123	15 668	15 363
Miscellaneous	13 135	*b*579 038	*b*353 664
Total	$3 182 447	$3 119 835	$3 300 383

a Includes Solvay Process Co.'s lime.
b Includes lime made by Solvay Process Co. and Union Carbide Co., also rubble and riprap.
c Included in "Miscellaneous."

Crushed stone. The use of crushed limestone for road metal, concrete and railroad ballast is constantly increasing. Large, well equipped crushing plants in Erie, Genesee, Dutchess and Rockland counties are turning out enormous quantities, while smaller plants are located throughout the rest of the limestone areas. The railroads at the present time are largely using crushed stone in place of gravel as ballast; the agitation for good macadam roads has also aided in the demand, while the barge canal and other concrete constructions have increased the use of concrete. In the barge canal contracts, the quarries and crushers are located but temporarily and part of the stone thus used is probably not included in our tabulations.

The total value of the production of crushed stone for the year was $1,744,314, the largest yet recorded for any year. In 1908 the value was $1,647,629. Erie county leads in production with a value of $447,605 against $369,754 in 1908. It is followed in order by the following counties, the production for 1908 being inclosed in brackets; Dutchess $365,661 [$233,261]; Rockland, one large producer; Genesee $123,784 [$122,310]; Onondaga $110,886 [$108,768].

Lime. Since the earliest days of the State, the manufacture of lime has been carried on; and many active or abandoned lime kilns are found in all limestone sections. The prevailing economic conditions, however, have tended toward a consolidation of the industry and the manufacture is now mainly carried on from large well equipped plants. Warren county alone produces 38 per cent of the State's production, while the counties of Warren, Jefferson, Clin-

ton and Washington produce 71 per cent of the supply. The lime made by the Solvay Process Co. and the Union Carbide Co., since it is not marketed as lime, is not included in these tabulations.

The total production of lime for the year was valued at $452,-874 against $401,728 in 1908, a gratifying advance. The production of the four leading counties was as follows, the 1908 production being inclosed in brackets: Warren $175,830 [$170,832]; Jefferson $57,368 [$52,454]; Clinton $47,488 [$45,000]; Washington $30,000 [$36,960]. Large increases of production were also reported from the following counties: Albany, Dutchess, Lewis and Ulster.

Building stone. The use of the limestones of the State for building purposes seems to be largely local, the stone rarely being shipped to any great distance from the quarry. Competition with Bedford limestone and Ohio sandstone seems impossible and our native limestones show little advance in production from year to year, while the past year a strong decline was experienced. In addition to competition with extralimital material, the increased use of concrete for foundation work has tended to restrict the use of cut stone, while at the same time it increases the use of rubble, riprap and crushed rock.

The increase in production in 1908, attributed to the activity of the quarry at Newport, Herkimer co. and those in Schoharie county, was not continued in 1909. The Newport Construction Co.'s quarry was idle; the Schoharie quarries did a slightly decreased business, while a loss was experienced from Jefferson county.

The total production amounted to $217,109 against $245,655 in 1908 and $189,782 in 1907. Erie county continued to be the largest producer with a total of $119,134 or about 54 per cent of the total for the State. Following in order are Schoharie county with $25,885; Onondaga county, $17,380 and Clinton county, $13,325.

Furnace flux. The limestones of the State are widely used for flux in blast furnace operations. The Onondaga limestone is extensively quarried for such purposes, the larger quarries being in Williamsville and Clarence, Erie co., and North Leroy, Genesee co. The Niagara limestone which is dolomitic entered the field during the year as a flux and a large amount of such rock was quarried by the Empire Limestone Co. at Pekin, Niagara co.

The Gouverneur district in St Lawrence co., was also a large producer, the stone being in reality a crystalline limestone or marble. One firm is in operation at Gouverneur, and the stone

is shipped to furnaces in Ohio. Quarries are also in operation in Chazy, Clinton co. and the stone is shipped to the blast furnaces at Port Henry. Aside from these larger quarries, small amounts are obtained from quarries throughout the State but are used only locally in small furnaces.

The total production of flux for 1909 was $434,311 a gain of 88 per cent over the production of 1908 which amounted to $230,117. This production even exceeded that of 1907 and was the largest yet recorded for the industry. Of the total production, Erie county contributed $257,966 or 59 per cent and Genesee county $99,814 or 22 per cent, both showing large increases in production over 1908. Clinton and St Lawrence counties also reported largely increased productions while Niagara county made its first appearance as a large producer.

Production of limestone by counties in 1908

COUNTY	CRUSHED STONE	LIME MADE	FURNACE FLUX	BUILDING STONE	OTHER USES	TOTAL
Albany........	$104 250	....	....	$200	$500	$104 950
Cayuga........	39 051	$400	$510	6 216	2 500	48 677
Clinton........	18 136	45 000	5 640	8 250	7 592	84 618
Columbia......	3 700	....	4 500	360	....	8 560
Dutchess......	233 261	1 600	....	....	512	235 373
Erie..........	369 754	515	138 563	112 409	33 711	654 952
Fulton........	4 666	12 840	....	....	....	17 506
Genesee.......	122 310	2 520	53 407	2 461	100	180 798
Greene........	3 270	....	....	1 000	....	4 270
Herkimer......	6 085	3 607	....	30 000	5 180	44 872
Jefferson......	2 500	52 454	....	13 513	133 521	201 988
Lewis.........	780	4 000	....	888	80	5 748
Madison.......	27 993	....	3 000	....	14 340	45 333
Monroe........	14 002	21 756	....	3 981	176	39 915
Montgomery...	8 561	....	....	5 343	6 416	20 320
Niagara.......	12 950	5 400	....	2 622	16 500	37 472
Oneida........	26 150	....	50	4 000	1 000	31 200
Onondaga.....	108 768	a1 450	....	16 709	a355 105	482 032
Rensselaer.....	15 700	....	100	3 425	6 750	25 975
St Lawrence...	462	7 305	14 606	723	562	23 658
Saratoga......	12 259	....	....	625	2 271	15 155
Schoharie.....	32 971	232	....	30 555	....	63 758
Seneca........	1 340	400	60	1 120	2 980	5 900
Ulster........	169 414	2 530	....	....	500	172 444
Warren........	16 000	170 832	....	1 005	3 357	192 194
Washington....	55 860	36 960	....	250	....	93 070
Westchester....	38 509	22 927	37	....	....	61 473
Other counties b	198 927	9 000	9 644	....	1 053	218 624
Total.....	$1 647 629	$401 728	$230 117	$245 655	$594 706	$3 119 835

a Lime used by Solvay Process Co. included in "Other uses."
b Includes Essex, Ontario, Orange, Orleans, Rockland and Schenectady.

Production of limestone by counties in 1909

COUNTY	CRUSHED STONE	LIME MADE	FURNACE FLUX	BUILDING STONE	OTHER USES	TOTAL
Albany........	$105 440	$4 600	....	$200	....	$110 240
Cayuga........	36 734	400	$610	6 835	$2 500	47 079
Clinton........	21 735	47 488	14 200	13 325	532	97 280
Columbia......	9 883	....	3 460	200	....	13 543
Dutchess......	365 661	4 000	....	....	....	369 661
Erie..........	447 605	375	257 966	119 134	28 684	853 764
Fulton........	....	18 900	....	....	....	18 900
Genesee.......	123 784	5 400	99 814	1 225	....	230 223
Greene........	4 177	....	....	500	30	4 707
Herkimer......	6 611	3 350	....	....	....	9 961
Jefferson......	1 000	57 368	....	562	153 420	212 350
Lewis.........	940	8 000	....	887	2 359	12 186
Madison.......	24 176	....	....	840	12 000	37 016
Monroe........	20 218	23 593	....	3 917	2 454	50 182
Montgomery...	42 832	....	....	10 440	1 503	54 775
Niagara.......	2 060	3 000	27 920	5 587	612	39 179
Onondaga.....	110 886	*a*600	....	17 380	231 842	360 708
Rensselaer.....	15 700	....	75	3 550	6 750	26 075
St Lawrence...	6 630	5 350	23 994	2 993	1 103	40 070
Saratoga......	11 316	....	....	100	....	11 416
Schoharie......	18 913	400	....	25 885	....	45 198
Seneca........	1 050	360	40	865	210	2 525
Ulster.........	48 022	11 360	....	1 200	....	60 582
Warren........	22 938	175 830	....	1 156	1 750	201 674
Washington....	47 660	43 200	....	....	2 000	92 860
Westchester....	8 252	30 000	....	....	3 465	41 717
Other counties *b*	240 091	9 300	6 232	328	561	256 512
Total.....	$1 744 314	$452 874	$434 311	$217 109	$451 775	$3 300 383

a Lime used by Solvay Process Co. included in "Other uses."
b Includes Essex, Ontario, Oneida, Orange, Rockland and Schenectady counties.

Marble

The marbles of the State are confined to two main areas: Gouverneur, St Lawrence county and southeastern New York.

The Gouverneur stone is a rather coarse grained gray or bluish marble taking a good polish. It is quarried as "light," "medium," "dark" and "extra dark." It is utilized largely for monumental work and as dressed building stone.

In Dutchess county, near South Dover, a handsome white marble, equal to much of the imported stone, is extensively quarried and shipped to many points in the Eastern States. Its uniformity of color, its beauty and durability warrant for it a more extended use. It is to be hoped that with the two well equipped firms in activity the stone will become more widely known.

The Westchester county quarries near Tuckahoe, once so extensively developed, are no longer in operation with the exception of a small amount of stone quarried for crushing. At Ossining also small amounts of stone are crushed for the manufacture of artificial stone.

At Plattsburg, Clinton co., the Rutland-Florence Marble Co. continues to quarry small amounts of the mottled pink and gray Chazy limestone as marble for interior decorations.

The Trenton limestone at Glens Falls is also quarried and sold in the rough. It is a firm, compact, black limestone, often classed with marbles because of the fine polish which can be given to it.

The total production of marble for the year 1909 was $380,016 as against $692,857 in 1908 and $1,571,936 in 1907. This production was the smallest reported in a number of years. The Gouverneur district reports the most disastrous year ever known, while at South Dover a large curtailment of production was also shown. The reasons for such a condition can not be ascertained. The use of marble for decoration seems, in general, to have been increasing in the last few years, while as a monumental stone, no new developments would seem to have arisen to curtail its use. The curtailment seems to have been general throughout all the districts and over all products. Reports from Gouverneur would seem to indicate, however, that better conditions are likely to prevail in 1910, while in the South Dover district, the advent of the Dover White Marble Co., in addition to the South Dover Marble Co., will bring about a more lively trade.

Production of marble

VARIETY	1907	1908	1909
Building marble	$1 408 190	$567 444	$262 934
Monumental	152 746	111 492	104 495
Other kinds	11 000	13 921	12 587
Total	$1 571 936	$692 857	$380 016

Sandstone

Sandstones are widely distributed over the State, almost every county having some beds. The largest unbroken area is that extending across the southern tier of counties from Chautauqua county on the west to Ulster county on the east. This series will be described more fully under bluestone. North of this belt and extending in an east-west direction across western and central New York, are a series of sandstone strata that include the Oriskany, the Clinton and the Medina sandstones. Of these the latter, the Medina sandstone, is the only one of commercial importance. The main area covered by this stone lies along the southern shore of Lake Ontario in Niagara, Orleans, Monroe and Wayne counties. The stone is a medium grained, red sandstone, free from injurious impurities and easily dressed. Associated with it in places are white layers. It makes a very handsome building stone and has been much used for that purpose. Its main use, however, is for curbing and paving blocks. Many large quarries are actively engaged in getting out the stone for such purposes, the majority of them located in Orleans county between Medina and Holley.

The Potsdam sandstone is found in northern New York, around the border of the Adirondacks, from Jefferson county to Lake Champlain. It is one of the hardest, most durable and at the same time handsome sandstones in the country and it deserves a wider use. Its delicate pinkish color and its banding give it a most pleasing appearance. It is quarried in Franklin, Jefferson and St Lawrence counties and sold mainly as building stone or flagging.

The Hudson River series, comprising irregular strata of slates, sandstone and limestone, affords, at a few places, a sandstone suitable for quarry purposes. Quarries in this series are located in Rensselaer and Dutchess counties. Sandstones of Triassic age, known as "brownstones" were formerly quarried near Nyack, but the industry is now practically abandoned.

Bluestone. This variety of sandstone is bluish in color, fine grained and is jointed and bedded in such a regular manner that with careful selection of a quarry site, flagging and curbing can be extracted with a minimum amount of after-dressing. The bluestone is, for that reason, in demand chiefly for these purposes. The quarries are located in Greene, Ulster, Delaware and Sullivan counties, and thence west to Chautauqua

county. In the Hudson river and Delaware river areas, the industry affords no inconsiderable income to the farmers living in the hilly country, where other resources are rather limited. The stone is quarried the year round except in severe winter weather, and in the spring is hauled down the hillsides to the railway sidings or river docks where it is purchased by wholesale dealers and shippers. From thence it is shipped by barges on the Hudson river or by rail in other districts, to New York city, Philadelphia, and other coast cities, or inland to New York State cities.

In Wyoming county, the rock varies slightly in its jointed character and is of more value as a building stone. Quarries are operated on a larger scale and large quantities of dressed building stone are turned out.

The total production of sandstone in 1909 was $1,839,798 against $1,711,585 in 1908 or an increase of 7 per cent. This total, however, falls short of that for 1907 which was $1,998,417.

Bluestone contributed toward the above total $1,301,959 or 70 per cent, as against $1,151,386 in 1908. The increase seems to have been general over all the bluestone districts but among the products the increase was shown only in the building and crushed stone, the curbing and flagging showing a decreased production. This is no doubt due to the large use of cement in the construction of sidewalk and curb. In the table of production, the increase in the building stone is not apparent because of the fact that the stone used for sills and coping is included under "all other," as is also the Belgian bridge.

Sandstone, other than bluestone, showed a total production of $537,839 against $570,229 in 1908. The decrease was due to the small production of building stone in Orleans county and a large decrease in the production of crushed stone. The production of paving blocks which are obtained almost entirely from Orleans county, increased, the value being $248,751 against $239,239 in 1908.

Trap Rock Co. and Haverstraw Trap Rock Co., and the formation of the Ramapo Trap Rock Co., the latter not being active in 1909.

Production of trap

MATERIAL	1908		1909	
	CUBIC YARDS	VALUE	CUBIC YARDS	VALUE
Crushed stone for roads....	755 754	$584 837	868 650	$823 696
Crushed stone for other purposes..................	175 144	138 026	226 681	237 732
Paving blocks, etc.........	....	....	....	....
Other.....................	1 113	910	....	....
Total................	932 011	$723 773	1 095 331	$1 061 428

TALC

The talc mines in St Lawrence county were operated last year on about the usual scale. During the last decade the production has averaged about 65,000 tons a year and has not varied from that amount by more than a few thousand tons. In 1907 the total fell off to 59,000 tons, due to the destruction by fire of one of the large mills, but this shortage was counterbalanced in 1908 by an output of 70,739 tons. In 1909 the production may be placed at about 65,000 tons. The value of the product was approximately $617,500 as compared with $697,390 in 1908.

A general description of the St Lawrence county deposits and of their industrial development was given in the issue of this report for 1908. Following the recent consolidation of mining interests by which the properties formerly operated by the United States Talc Co. and the Union Talc Co. came under the control of the International Pulp Co., no further changes of note have occurred. The latter company has been for some time the largest producer in the region and now occupies a dominant position in the production and sale of ground talc in this country.

The Ontario Talc Co. was the only independent producer in the district last year. The Uniform Fibre Talc Co. of New York, has a mill under construction at Talcville and is expected to begin operations during the current season. Its mining property is on Wintergreen hill, just west of Talcville.

Production of talc in New York

YEAR	SHORT TONS	VALUE	VALUE PER TON
1896	46 089	$399 443	$8 67
1897	57 009	396 936	6 96
1898	54 356	411 430	7 57
1899	54 655	438 150	8 02
1900	63 500	499 500	7 87
1901	62 200	483 600	6 99
1902	71 100	615 350	8 65
1903	60 230	421 600	7 ..
1904	65 000	455 000	7 ..
1905	67 000	519 250	7 75
1906	64 200	541 600	8 43
1907	59 000	501 500	8 50
1908	70 739	697 390	9 86
1909	65 000	617 500	9 50

The talc from the St Lawrence county mines is mainly of fibrous nature and it is this feature which makes it particularly valuable for incorporation in paper stock. The foliated variety occurs in some of the deposits but is utilized to a smaller extent; it is admixed in small amount with the fibrous article or is ground separately for coating of wall papers and other uses.

Though the district which lies southeast of Gouverneur has attracted most attention, the occurrence of talc elsewhere in the Adirondack region has long been known. During 1909 a deposit situated near Natural Bridge, Lewis co., was under development by the St Lawrence Talc & Asbestos Co. The talc is found there in somewhat similar relations geologically to those in the more northerly district, but it has the character rather of amorphous talc or soapstone, resembling the material from the Southern States. The recent operations are reported to have revealed a large quantity of rock of good quality. Natural Bridge is near the southern end of the belt of crystalline limestones and schists which belong to the same series as the limestones and schists in which the fibrous talc deposits are found, the two belts being about 10 miles apart and trending parallel in a northeast-southwest direction.

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INTRODUCTION

Gypsum has been mined in New York for the last century. The present development of the industry dates back, however, scarcely more than a decade. During this interval the production has grown to many times its former proportions, and from a relatively insignificant position the State has advanced into prominence with regard to both the mining and manufacture of gypsum. The basis of this progress is supplied by great natural resources combined with unexcelled market advantages.

The field investigations in connection with this report have extended over the whole area within which workable deposits are known to exist. Some of the occurrences visited have not been noted hitherto; the recent extensions of productive operations, moreover, have permitted a more detailed study of the deposits and their distribution than was possible a few years ago.

Acknowledgment is due the mining companies and others for many courtesies received by the writers. The privilege of inspecting the workings and plants was freely granted, and records of

exploration and other information were furnished, without which the report could not have been prepared.

The field notes have reference mainly to conditions in the summer of 1909. They were made by Mr Leighton.

HISTORY OF THE GYPSUM INDUSTRY IN NEW YORK

Statistics of production

The discovery of the gypsum deposits must have been practically coincident with the first permanent settlement of central and western New York, which followed close upon the termination of the War of the Revolution. The earliest mention that is still a matter of record relates to an occurrence on lot 90, Camillus township, Onondaga co., said to have been discovered by W. Lyndsay in 1792. In 1808 a stock company was organized to exploit this deposit for land plaster. The beds in Sullivan township, Madison co. were worked during the War of 1812 and the output was shipped to the Hudson river and as far away as Philadelphia. It appears that gypsum was quarried at Union Springs as early as 1811 and by 1822 several thousand tons are reported to have been shipped each year from that place to Pennsylvania. The sole use of the product was as agricultural plaster.

At the time of the first geological survey (1836–41) the quarrying of gypsum was actively pursued along the Salina belt from Madison to Genesee county. The reports of that survey mention operative quarries in the towns of Wheatland, Leroy, Seneca Falls. Union Springs, Phelps, Manlius, Camillus and Sullivan; and their output was then nearly as large probably as at any time in the succeeding 50 years.

Though the deposits were under active exploitation long before those of Michigan, Ohio and the Middle Western States had become productive, they have played little part in the development of the trade in calcined plasters or their technology. It was only after this branch of the industry had become firmly established in other parts of the country and American practice had become fairly perfected that the local deposits began to receive attention as a source of material for calcined plaster. The first production of plaster of paris was reported in 1892 and amounted to 75 tons. With the successful issue of the early undertakings the natural advantages of the State for manufacture and marketing have contributed a powerful impetus to this branch of the business, which is now the most important of all.

The production of gypsum and gypsum plasters, so far as statistics are available, is shown in the accompanying table. The figures for the years 1889 to 1903 inclusive are taken from the annual volumes of *The Mineral Resources*, while those subsequent to the latter year are abstracted from the bulletins of the New York State Museum. The total for 1843 is an estimate based on information given in the early reports of Hall and Vanuxem.

While the production for the years previous to 1889 can not be stated definitely, it is estimated that the aggregate output since the beginning of the industry in the State has been between 4,000,000 and 5,000,000 tons. A total approximating the truth may be derived by using the known figures for the period 1889–1908 and by

Production of gpysum and gypsum products in New York State

YEAR	TOTAL OUTPUT		SOLD AS LUMP GYPSUM		SOLD AS LAND PLASTER		SOLD AS CALCINED PLASTER	
	Short tons	*a*Value	Short tons	Value	Short tons	Value	Short tons	Value
1843	33 000	....	....	....	....	....	....	....
1889	52 608	$79 476	21 537	$21 642	31 071	$57 834	....	....
1890	32 903	73 093	3 072	2 858	29 831	70 235	....	....
1891	30 135	58 571	6 730	5 058	23 405	53 513	....	....
1892	32 394	61 100	7 887	5 661	24 407	55 039	75	$400
1893	36 126	65 392	10 979	8 198	22 802	49 221	1 813	7 973
1894	31 798	60 262	10 554	7 885	16 804	36 993	3 335	15 384
1895	33 587	59 321	12 182	6 492	16 765	36 664	3 480	16 165
1896	23 325	32 812	10 256	6 177	13 069	26 635	....	....
1897	33 440	78 684	5 394	3 516	15 826	34 368	9 200	40 800
1898	31 655	81 965	2 243	1 353	17 112	40 066	9 275	40 550
1899	52 149	105 533	1 900	1 677	13 924	25 290	26 443	78 566
1900	58 890	150 588	1 402	1 122	21 444	47 292	27 979	102 174
1901	119 565	241 669	11 678	10 908	33 591	61 093	55 273	169 668
1902	110 364	259 170	9 153	15 184	25 981	43 750	60 184	200 236
1903	137 886	462 383	9 304	15 439	37 850	77 392	75 613	369 552
1904	151 455	424 975	9 768	14 652	33 712	62 438	88 255	347 885
1905	191 860	551 193	27 980	34 095	19 815	39 014	130 268	478 084
1906	262 486	699 455	34 626	58 076	20 656	46 094	163 451	595 285
1907	323 323	751 556	91 060	179 432	15 441	38 859	145 684	533 265
1908	318 046	760 759	95 146	171 747	5 712	14 255	160 930	574 757

a Value is based on the marketed products.

estimating the previous production according to reasonable averages. The estimate for the year 1843 and the reported outputs for several years after 1889 show that until late years there was a fairly steady market for the gypsum as land plaster material. It is probable that the production did not average over 10,000 tons a year previous to the opening of the Erie canal, for until then the facilities for shipment were limited. From the year of its opening (1826) until 1889 the average was probably about 35,000 tons. For the period 1810–88 the production may be estimated accordingly at

2,400,000 tons, while the actual output in the period 1889–1908 has been 2,063,995 tons. The combined total in round numbers is 4,464,000 tons.

The production and imports of gypsum for the United States during the period 1890–1908 are given in the table herewith.

A comparison of the statistics in the two tables shows that New York has held its place in the general industry of the country which has increased its output over 800 per cent since 1890. The local output in 1908 was approximately 18 per cent of that recorded for the United States in the same year. There is little doubt that the use of gypsum in this country will continue to expand during the immediate future, though most likely at a slower rate than that exhibited in the last few years.

Production and imports of gypsum for the United States

YEAR	PRODUCTION a		IMPORTS b	
	Short tons	Value	Short tons	Value
1890	182 995	$574 523	178 857	$229 859
1891	208 126	628 051	119 817	226 319
1892	256 259	695 492	187 936	308 011
1893	253 615	696 615	167 663	211 924
1894	239 312	761 719	164 527	196 060
1895	265 503	797 447	195 844	237 231
1896	224 254	573 344	183 561	215 526
1897	288 982	755 864	165 865	195 714
1898	291 638	755 280	169 039	199 865
1899	486 235	1 287 080	199 844	239 853
1900	594 462	1 627 203	212 990	249 057
1901	633 791	1 506 641	238 310	258 067
1902	816 478	2 089 341	309 014	208 167
1903	1 041 704	3 792 943	269 484	324 163
1904	940 917	2 748 325	297 516	332 582
1905	1 043 202	3 029 227	403 119	423 204
1906	1 540 585	3 837 975	440 586	487 546
1907	1 751 748	4 942 264	445 890	499 030
1908	1 721 829	4 138 560	302 047	327 627

a The figures of production are based on the crude gypsum, while the values are for the marketable products.
b Includes crude and calcined gypsum, but not manufactured plaster of paris.

COMPOSITION AND CHARACTERS OF GYPSUM

Chemical and mineralogic characters. Gypsum is a hydrated calcium sulfate with the formula $CaSO_4 . 2H_2O$. Its ideal composition is represented by the following percentages by weight: lime

(CaO) 32.5; sulfuric acid anhydrid (SO_3) 46.6; water (H_2O) 20.9. The crystallized variety of gypsum may show a close approach to these percentages, but the ordinary rock and earthy gypsum employed in the industries contains a variable proportion of foreign matter which amounts generally to several per cent of the whole mass.

The crystals of gypsum belong to the monoclinic system and are usually formed by a simple combination of faces. According to the relative development of the latter, they may be tabular or flattened, prismatic, or elongated into acicular individuals. They are sometimes twinned so as to yield arrowhead forms. The common types of crystals are represented by the accompanying figures. The

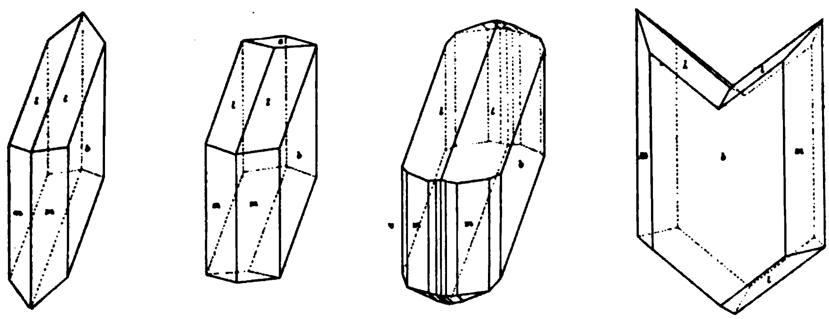

Fig. 1 Crystals of gypsum. At the right a twinned form. (H. P. Whitlock, del.)

crystals are characterized by an easy cleavage parallel to the principal plane (face *b* in figures). Thin flakes so produced are flexible, but not elastic like mica to which they bear some resemblance. If bent sharply they break in a diagonal direction with the production of fibers.

The cleavage plates of gypsum can be distinguished from foliated talc by their greater hardness, which is inferior, however, to that of anhydrite or calcite. Gypsum occupies the second place in the Mohs scale of hardness, according to which certain minerals are selected as standard and numbered in order of increasing hardness from 1 to 10. In this scale talc is 1 and calcite 3. The specific gravity of gypsum when pure is 2.3.

Gypsum is only slightly soluble in pure water (one part dissolving in 415 parts of water at 32°F. and in 368 parts of water at 100.4°F.) but its solubility is considerably increased in the presence of salts of the alkalis, such as sodium and potassium chlorids. Concentrated acids are generally poor solvents, sulfuric having no

effect; dilute hydrochloric acid is the common solvent for laboratory purposes.

Gypsum parts readily with its water of crystallization. By partial dehydration it is converted into the half hydrate ($CaSO_4 \cdot \frac{1}{2}H_2O$), which is plaster of paris. In ordinary practice of plaster manufacture where the dehydration is performed in closed receptacles, the temperature is not allowed to exceed about 400°F. If the temperature is maintained above that point for any length of time, complete dehydration results and the product then has the composition of the mineral anhydrite ($CaSO_4$). This mineral is insoluble and useless for plaster, but the artificial product, if certain conditions are observed in burning, is capable of uniting with water and enters into special grades of plaster. The dehydration of gypsum can be accomplished at temperatures much lower than those in manufacturing practice under the influence of hygroscopic materials like concentrated acids or currents of dry air.

Varieties of gypsum. Crystallized gypsum is commonly known as selenite. It is colorless and transparent in pure condition. It finds limited application in optics and has been used in the past as a substitute for glass for some purposes.

Satin spar is the name given to the fibrous variety, which is really an aggregate of parallel or radiating acicular crystals. It ranges from white to colorless, has a pearly luster and is often found in veins which intersect the larger bodies of massive gypsum and its inclosing rocks.

Rock or massive gypsum is the usual gypsum of commerce. It is generally made up of an intricate intergrowth of small crystals. The white or delicately tinted variety of even texture is the alabaster used for sculptures and objects of art. More often the rock gypsum has a dark color such as gray, drab, brown or nearly black, according to the character and amount of impurities present. These include organic matter, lime and magnesia carbonates, clay, iron oxids and silica. The actual proportion of gypsum in rock from different localities ranges within wide limits, from as low as 50 or 60 per cent up to 97 or 98 per cent in exceptionally pure types.

Still another variety of gypsum, known as gypsite or gypsum earth, is common in some parts. It is an incoherent surface deposit consisting of small gypsum crystals mixed with quartz, lime carbonate and organic matter. It occurs in the Middle Western States, where it is used to some extent for plaster manufacture, and in Europe.

Anhydrite. This mineral is mentioned here on account of its close relation to gypsum. It differs chemically in the absence of any water of crystallization and like overburned plaster lacks the property of setting when mixed with water. If exposed to weathering influences for a long time, however, it will absorb moisture and change to gypsum, a process that has probably taken place frequently in nature. The change involves an increase of 60 per cent in volume. The reverse reaction — the change of gypsum to anhydrite — may also occur under the influence of heat and pressure superinduced for instance by the burial of gypsum beds beneath a great thickness of overlying strata.

Anhydrite crystallizes in the orthorhombic system and cleaves in three directions normal to each other. Cleavage fragments are thus rectangular. Its hardness is from 3 to 3.5, noticeably greater than that of gypsum.

Beds of anhydrite occur frequently in association with gypsum, as might be expected from their similar origin. From a solution of calcium sulfate which is saturated with sodium chlorid ether anhydrite or gypsum may be deposited according to the temperature.[1]

THE USES OF GYPSUM

Crude and ground gypsum

Ornamental and building stone. Alabaster, the semitranslucent white gypsum, which comes mostly from England, Italy and Spain, finds a demand for ornamental uses, less in this country than abroad. Very little gypsum is now used for ornamental or building purposes in the United States. According to the Iowa Geological Survey,[2] the gypsum around Fort Dodge was quite extensively quarried at one time for various kinds of structural work and for sidewalks. The stone has a tendency, it is said, to bleach and crack on the surface when exposed to the sun though it does not actually disintegrate to any harmful extent.

Agricultural plaster. The most important use of raw gypsum is as a soil amendment, for which purpose the rock, pure or impure as it may be, is simply crushed and ground to a powder. The employment of land plaster is of very ancient origin, going back at least to Roman times, and its beneficial influence has been advocated repeatedly by prominent writers on agriculture. But of late

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[1] Van't Hoff, J. H. & Weigert, F. Sitzungsber. Akad. Berlin. 1901. p. 1140. The deposition of anhydrite from sea water takes place at a temperature of 25° C. or 70° F.

[2] An. Rep't. 1895. v. 3, pt 2, p. 293.

there is manifest a decided decrease in the land plaster industry, which seems to indicate a growing uncertainty among agriculturists of the positive value of gypsum as a general fertilizer. The enormous development of the trade in calcined plasters, however, may have had something to do with bringing about this decline by diverting the attention of the producers to a broader, if not more remunerative, outlet.

The literature on the subject of land plaster is so voluminous that it can hardly be summarized profitably in a few pages. In fact the real action of gypsum on soils appears even now to be little understood. Storer,[1] one of the more recent writers, ascribes the effects to a combination of chemical and mechanical processes. According to him ground gypsum acts mechanically in flocculating loose soils and disintegrating stiff clay soils. In a chemical way it releases part of its oxygen to combine with nitrogenous and carbonaceous substances in the soil and also decomposes silicates like feldspar, from which it sets free potassium sulfate available for assimilation by the plant roots. The last reaction is thought to be the more important. Aside from the possible benefit of the contained lime, gypsum appears thus to add no direct fertilizing element to land.

Gypsum in portland cement manufacture. According to E. C. Eckel[2] gypsum is universally employed as a retarder in portland cement manufactured by the rotary kiln process, such cement being characterized by a high lime content and rapid set. From 2 to 3 per cent of gypsum is added usually to the clinker before grinding, in order to insure thorough incorporation. Besides its function in retarding the set of portland cement, the gypsum seems to exert a strengthening influence, at least in the early stages of setting. The addition is more often made in the form of raw gypsum than as calcined plaster, though of course the latter is more effective weight for weight. The lower value of raw gypsum, however, more than counterbalances the increased quantity necessary, as compared with calcined plaster.

Miscellaneous uses. Raw white gypsum is ground and made into crayons which are said to be superior in some respects to chalk crayons. The American Crayon Co. of Sandusky, O. manufactures such crayons along with a variety of similar materials.

Finely ground white gypsum is sold under the name of terra alba for various purposes. It is a common basis of cheap white

[1] Chemistry of Agriculture. 1887. 1:206.

[2] Cements, Limes and Plasters. 1905. p. 534 et seq.

paints and has been found in food stuffs. Its more legitimate uses are in the preparation of insecticides and pharmaceutical supplies.

A peculiar use of gypsum is found in the wine-growing districts of Spain and Greece, where it is said to be added to red wines to hasten their ripening before bottling and to give them a more fiery color.[1] The process is called "plastering." The gypsum unites with the tartar or argol to form tartrate of lime which precipitates and clears the wine, while the soluble potassium sulfate that is formed reacts upon the phosphates releasing phosphoric acid which enhances the color intensity.

The presence of small amounts of gypsum in waters used for brewing is said to be advantageous.

Various processes have been devised for hardening blocks of crude gypsum so as to imitate marble and other materials. The blocks after being dehydrated by heat so as to render them porous are treated with chemicals such as ammonia, ammonium sulfate, copperas ètc. A cheap substitute for meerschaum is made in this way with the use of stearic acid or paraffin.[2]

Uses of calcined gypsum

Molding and casting. The ordinary calcined gypsum, or plaster of paris, has a great number of uses. A very familiar one is as a material for making casts and molds. The value in casting objects is due largely to its property of swelling slightly as it sets, thus filling out the mold perfectly. The pottery industry consumes large quantities of plaster of paris annually in the form of molds for casting china and porcelain wares; the porous nature of such molds is an important advantage, permitting the water of the clay to escape.

The manufacture of plate glass likewise calls for large quantities of plaster. The glass sheets are imbedded in the plaster during the process of grinding and polishing. It is estimated that over 40,000 tons are consumed each year in the United States by the glass industry.

Building and construction. Stucco and staff are but other names for plaster of paris; the former in its application to interior decorations and as a white coating for wall surfaces and the latter to building construction and exterior decorations.

A related use of plaster of paris, first introduced in Germany but of rapidly growing importance in this country, is in the manufac-

[1] Scientific American Sup. 1907. 63:26033.
[2] Mich. Geol. Sur. An. Rep't. 1904. 9:206.

ture of plaster boards or blocks for the construction of walls and floors. The boards or sheets are built up in alternating layers of plaster and some supporting material such as paper, excelsior, fibrous talc, etc. They are nailed directly to the studdings and joists of buildings and are then covered with a fresh coat of plaster. Further details of their manufacture are given on page 45.

The employment of gypsum wall plasters in the place of lime plasters has developed rapidly of late years and now represents the most important single application of gypsum, at least in this country. Wall plasters consist of plaster of paris and some fiber-like hair or wood with the addition of a retarder. Their advantages over lime plasters are many, including more rapid set, greater spreading power, less shrinkage on drying, and ability to unite with coloring agents so as to produce any desired tint. On the other hand they are somewhat more expensive than lime and inferior to it in deadening sounds. A special preparation of plaster, glue and pigments is sold under the name of alabastine for the tinting of walls.

The manufacture of anhydrous plasters, of which Keene's cement and flooring plasters ("Estrichgips" of the Germans) are examples, is not carried on to any extent in this country. They are characterized by slow setting and superior hardness. Keene's cement, which is representative of a number of materials sold under special brands for hard finishing of walls, is made by calcining gypsum at red heat, after which the dehydrated plaster is immersed in a solution of alum and again ignited at high temperature. "Estrich" gypsum is the soluble form of artificial anhydrite prepared by calcination of gypsum at a temperature of about 500° C. for a period of not more than four hours. Further details concerning these plasters are given in another chapter.

Gypsum mortar can be made by using plaster ground to about the size of building sand and mixing with five to eight parts of water.[1] Tests prepared with German plaster show a crushing strength which for a number of different mixtures averages 11.1 kilograms per square centimeter, higher than the results obtained with lime mortar and exceeded only by those for cement mortar.

In mixing plaster for wall plaster or mortar it is pointed out that the plaster should be added to the water, the lumps quickly broken and the mass stirred as little as possible.[2] The plaster

[1] Scientific American Sup. 1907. 64:18.
[2] Scientific American Sup. 1907. 63:26207.

attains its greatest hardness with small amounts of water, 33 per cent being sufficient, of which 22 per cent remains in the hardened plaster. Plaster made with a large excess of water, as much as 200 per cent being often used, must necessarily be porous and less coherent as the crystals are not so tightly interlaced. It is also more absorbent of moisture and more liable to disintegration under change of temperature.

Other uses. Plaster of paris is also used in various printing processes.[1] Gypstereotyping is the process for the production from movable types of a solid printing plate of type metal. The printing form to be cast is secured in a metal frame or "chase," the type metal oiled and the space above it filled with plaster paste struck off even with the upper edge of the frame. After allowing it to set 15 minutes there remains a plaster mold into which the molten type metal can be poured.

In galvanoplastic work plaster molds saturated with stearin or wax and coated with graphite are used, and in rubber stamp making the rubber substance is pressed into a plaster mold and vulcanized.

GENERAL GEOLOGY

Occurrence of gypsum in New York State

The workable gypsum deposits are restricted to the Salina stage of the Upper Siluric or Ontaric system. The Salina includes also the rock salt beds of the State and is the equivalent practically of the Onondaga salt group as described in the early reports by Hall and Vanuxem. According to present nomenclature it is the basal subdivision of the Cayugan group, the uppermost of the three groups which together constitute the Upper Siluric succession in this region.

The Salina strata occupy two main areas within the State. The larger area contains the original sections which have become the types for comparison, and is the more important from an economic standpoint. It is represented by a belt that extends with uninterrupted continuity from Albany county on the east through central and western New York to the Niagara river and thence into the Province of Ontario. Its approximate limits are shown on the sketch map [pl. 1].

The belt terminates within or near the town of Knox, Albany co. by the thinning out of the strata, which in this part consist of only a few feet of shale. From Albany county westward the Sa-

[1] Scientific American Sup. 1907. 63:26033.

lina beds follow the range of hills that borders the Mohawk v on the south, their outcrop being at first well up the slopes at a distance of about 15 miles from the river itself. They pa the Mohawk as far as Oneida county, where, owing to incre thickness of the members and the flatter topography, they b to spread out so as to occupy a surface from 1 to 3 miles v Their course thus far is quite sinuous due to the numerous north and south valleys tributary to the Mohawk which pro long upstream deflections. Beyond Oneida county their out rapidly broadens; it is about 12 miles wide at the west end Oneida lake and fully 20 miles on the line of Cayuga lake wh it attains the maximum width for the State. The outcrop in w ern New York is more regular, maintaining an average of fr 7 to 10 miles and running almost in a straight line parallel to shore of Lake Ontario.

The Salina of this area is mainly a shale formation. The ot elements are gypsum which occurs in the upper shale beds; s near the middle of the section; and an impure limestone wh forms a thin capping to the shale in the central and western pa and discontinuous bands within the shale itself. The great ma of shale, except for a few feet at the base, is devoid of fossi therefore, in subdividing the Salina, use is made of these elemen which have a fairly constant horizon. The detailed stratigraph of this belt will be discussed later under a separate head.

The second area within which the Salina beds appear is in south eastern New York and here they show a quite different develop ment. They are found in two principal belts, one of which begin in Ulster county near the Hudson and follows the Shawangunk mountain uplift in a southwesterly direction across the State line into New Jersey and the other is in Orange county beginning near Cornwall and running parallel to the first along the Skunnemunk ridge. It may be remarked that the true sequence of the strata in this region has only recently been established. Our knowledge of the wide development which the Salina here shows has come largely through the work of C. A. Hartnagel[1] whose conclusions derived from stratigraphic evidences have been fully confirmed by study of newly discovered fossil-bearing sections. The main members of the Salina are conglomerate at the base, shale and sand-

[1] Notes on the Siluric or Ontaric Section of Eastern New York. N. Y. State Pal. An. Rep't. 1903. p. 342 et seq. Also Upper Siluric and Lower Devonic Sections of the Skunnemunk Mountain Region. N. Y. State Mus. Bul. 107. 1907. p. 39 et seq.

New York. The Salina of this region has been so recently recognized that little attention has been given to its exploration and the descriptions are based wholly on surface exposures. It is

highly improbable that any valuable deposits occur in the northern sections, where conglomerates and sandstones are the prevailing strata. If present at all, they will be found in the extreme southern part near the New Jersey border, in association with the shales which, as before stated, are here much thicker and even become the predominant member of the series.

In so far as the climatic factor may be concerned in the formation of the salt and gypsum, conditions must have been very similar in the two regions. The long continued concentration of the Salina seas by evaporation was widespread throughout the northeastern section of the interior basin as shown by the occurrence of one or both minerals in the Salina of Ontario, Ohio and Michigan, and there is no reason for believing that the climate was essentially less arid or otherwise different in the nearby part of the Atlantic basin, especially as the intervening barrier had undergone steady submergence during the epoch and was to disappear wholly before the close of Siluric time.

The colors of the strata in both regions are very similar. Deep red shales which some geologists regard as indicative of arid climatic conditions are a prominent feature of the sections in southern Orange county as well as of the Lower Salina of central New York.

Salina stratigraphy

The Salina stage as developed in central New York is divisible into five parts. The different members are seldom sharply delimited by physical features and owing to the scarcity of fossils throughout the beds their demarcation on the map is only possible in a general way. They are usually connected by zones of gradation; or sometimes the transition from one member to another is marked by a sequence of alternating layers. The latter is the condition, for example, of the passage from the waterlime that caps the formation, to the underlying shale.

The full series is found only in the part of the belt that lies west of Madison county. To the east they overlap upon the lower formations and gradually thin out to disappearance. The general relations of the members are shown in the accompanying diagram [fig. 2].

Bertie waterlime. This is an argillaceous, more or less magnesian limestone which forms the top member of the Salina stage. It is a persistent formation of quite uniform character. It extends from the Province of Ontario, where the type locality is found,

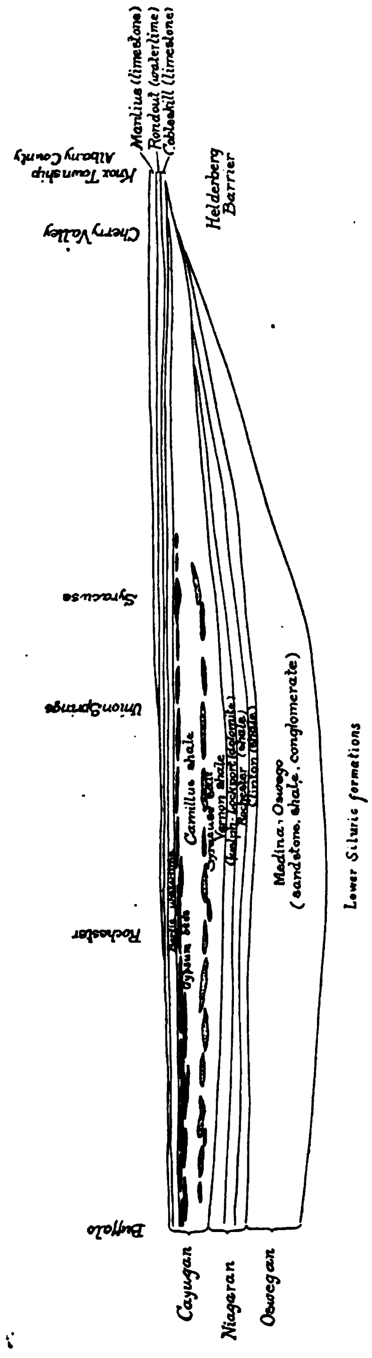

FIG. 2 Diagram indicating relative position and linear extent of the Upper Siluric strata in New York State

eastward as far as Schoharie county. In field exploration it serves as a very useful indicator, since the gypsum horizon lies just below, in the shales.

The limestone carries an eurypterid fauna which is also characteristic of the Pittsford shale at the base of the Salina. The intervening beds, however, are almost devoid of fossil remains, due undoubtedly to the unfavorable conditions for life that prevailed in the highly saline waters in which they were laid down. A common physical feature of the limestone is conditioned by the presence of numerous small cavities, which may so abound as to lend the appearance of a porous lava or slag. The cavities or cells are rounded or irregular in shape, sometimes elongated like worm tubes, and are frequently lined with a calcareous deposit. The structure was considered by some of the early writers to be of organic nature and the limestone was commonly designated the Vermicular limerock. This view of the origin of the cells was controverted by Vanuxem who pointed out the fact that they are often accompanied by hopper-shaped casts and impressions that have the clear outlines of rock salt crystals. There is little doubt but that they are due to the former presence of rock salt deposited with the limestone and afterward dissolved away.

The limestone possesses hydraulic properties and has been burned for hydraulic cement. The natural cement industry which was carried on for many years at Buffalo and Akron made use of this limestone which was employed to some extent also by the plants in Onondaga county. Its thickness varies from 60 feet in Canada and 50 feet in Erie county to 10 feet or less in eastern New York.

Camillus shale. Underneath the waterlime occurs a bed of soft shale, containing intercalated layers of magnesian limestone. The workable gypsum beds are found in this shale, at varying horizons, but mainly near the top. The color of the shale is commonly drab or gray with variations to olive-green and sometimes red. There are no fossils, except one or two species found in the intercalated limestones.

The thickness of the shale, together with the gypsum beds, averages perhaps 300 feet in the central part. Its outcrop is usually found just north of the line of ridges (known as the Helderberg escarpment in the eastern part of the State) formed by the great beds of overlying limestone and spreads out as a flat more or less swampy surface, physically continuous with the area of the Vernon shales. In the central section the outcrop is 2 or 3 miles wide.

The gypsum deposits are seamed more or less with shale which

divides them into separate beds, though there is little regularity in the number or thickness of the beds from place to place. The shale intercalations range all the way from mere films to layers several feet thick. While the main body of gypsum is usually found near the top of the Camillus shale, in some places directly beneath the waterlime, there are nodules, veins and layers of gypsum distributed all through the mass.

The limestone layers accompanying the shale represent transition stages toward the Bertie waterlime and are more abundant in the upper part. They show the same porous structure and hopper-shaped casts due to halite and contain varying percentages of magnesia. They are inclined to be more argillaceous than the characteristic waterlime, as might be expected, and on that account disintegrate rapidly when exposed to the weather.

The whole body of shale is impregnated more or less with lime and is often called marl in the reports of James Hall. The lime, however, is not of organic origin, but a precipitate probably from infiltering waters subsequent to the consolidation of the beds.

Syracuse salt. This is a very variable member composed of alternating beds of rock salt and shale, occupying a position between the Camillus and Vernon shales. There is no definite plane of demarcation at the top or bottom, and some geologists consider it a part of the Vernon shale rather than an independent unit, inasmuch as the presence of rock salt constitutes the only criterion for its recognition. Even that feature does not hold along the outcrop, for the salt has been removed in solution wherever the covering is less than about 1000 feet thick.

From the records of deep wells, the salt horizon is recognizable in the Salina from Madison county westward to Erie county. At Morrisville, Madison co. a single bed of salt about 12 feet thick occurs.[1] In Onondaga county there are as many as four beds of salt separated by shale and the extreme thickness of the salt and included rock is not less than 300 feet. At Ithaca seven beds of salt aggregating 248 feet and six beds of included shale with a total thickness of 222 feet are shown in a well record. In the Genesee valley, at the Retsof mine, the salt beds include 15 feet of rock and measure altogether 124 feet. In the Oatka valley of Genesee county the salt-bearing strata are from 100 to 135 feet thick. In Erie county they appear to range between 100 and 200 feet thick.

[1] The data relating to the thickness of the salt deposits are taken from Luther's "Geology of the Salt District." N. Y. State Mus. An. Rep't 50, v. 2. 1896.

Vernon shale. The thickest member of the Salina beds is the Vernon shale. It is a soft shale which by its usual deep red color can be distinguished more or less readily from the shales above the salt horizon. The strong ferric-oxid color is particularly prevalent in the eastern section where the beds can be traced across the country by the red, greasy clays that result from their decomposition. In the western part they are banded with greenish and grayish layers and bear some resemblance to the Medina shales. They are exposed from Herkimer county westward across Oneida, Madison, Onondaga and Cayuga counties, but beyond the Genesee river are generally buried under the drift, and as their color is no longer uniform, their line of outcrop is not so readily determined in that part. Thin layers of limestone also appear in the western counties, as shown in well sections.

The thickness of the Vernon shale reaches a maximum in Onondaga and Cayuga counties, where it probably averages about 500 feet. At Syracuse the salt well section shows 525 feet. Toward the east the shale thins rather rapidly and apparently disappears entirely in Herkimer county. Westward its thickness also diminishes, but from the information afforded by the few wells that have penetrated the Salina the shale seems to persist as far as Erie county at least. At Gardenville, in that county, a well record shows 200 feet of shale below the salt horizon. Most of the salt wells and shafts do not go below the lowest salt, though in one well at Warsaw the shale has been penetrated for a little over 100 feet.

The absence of any extensive deposits of gypsum in the Vernon shale is a noticeable feature, and one which seems to detract from the validity of the usually accepted view that the salt and gypsum beds are due to evaporation of sea water. If the sea during Siluric times approximated in composition the ocean of the present day as regards saline constituents — and the evidences strongly indicate a similarity of conditions — there should be a considerable deposit of gypsum below the salt beds. It is fairly certain, however, that the salt and gypsum do occur in their normal order. In some of the deep wells, as for instance at Attica and Aurora, gypsum was found below the salt, while there may be a large amount of gypsum in the aggregate disseminated through the mass of the Vernon shale, as has been suggested by Hartnagel.[1] It can only be said that the conditions generally were less favorable for the deposition of large and continuous beds of gypsum in the Vernon shale than later in

[1] Geologic Map of Rochester and Ontario Beach Quadrangles. N. Y. State Mus. Bul. 114. 1907. p. 30.

the period represented by the Camillus shale. This may have been due to the influx of fresh waters at frequent intervals, to which the great body of silt may be attributed.

Pittsford shale. In a few localities, the base of the Salina series is marked by a bed of dark shale which rests upon the Lockport dolomite. Though of no great thickness, the bed is given an independent position in the stratigraphic column on account of its fauna, most interesting of which are the eurypterids, found also in the Bertie waterlime. The Pittsford shale is a local phase of the Salina, first recognized a few years since from exposures at Pittsford near Rochester.

General structure of the Salina beds

The Salina strata which outcrop from Albany county to the Niagara river have been little disturbed since their emergence from the sea. They are nowhere involved in local folds and if at all faulted the displacement must be so slight as to escape general observation. They dip uniformly toward the south, the direction ranging from due south to a few degrees east or west of south.

Within the central and western parts their inclination averages about 40 or 50 feet to the mile, or roundly 1 foot in 100. This is probably no more than the slope of the sea floor on which they were laid down. In the eastern section the dip is somewhat higher, owing to the fact that the beds here experience in some measure the influence of the Appalachian disturbance, which came at the close of the Paleozoic era.

If the whole belt be considered as a unit it becomes apparent that the uplift has been accompanied by a certain amount of differential movement. This is well shown by a comparison of altitudes at different places along the outcrop. The following approximate elevations have reference to the outcrop of the gypsum beds in central and western New York. The localities are given in order from west to east.

LOCALITY	ALTITUDE Feet
Akron, Erie co	640
Oakfield, Genesee co	735
Wheatland, Monroe co	570
Garbutt, Monroe co	560
Victor, Ontario co	500
Seneca Falls, Seneca co	400
Union Springs, Cayuga co	460
Martisco, Onondaga co	600
Jamesville, Onondaga co	580
Lyndon, Onondaga co	640
Clockville, Madison co	650

In tracing the beds farther east, the gypsum disappears as a prominent feature, but the top of the Salina is found at about 900 feet at Clinton, Oneida co. and between 1400 and 1500 feet in Herkimer county. Beyond Herkimer county the elevation drops off rather rapidly so that in Schoharie county the single member of the series outcrops at about 600 feet.

The lowest point of outcrop is nearly on line with Cayuga lake where the belt is widest. There is a rise of about 300 feet between that point and Genesee county and of over 1000 feet in the interval between Cayuga lake and southern Herkimer county. The main part of the belt has thus the structure of a broad shallow syncline with an axis running north and south and with its eastern wing rising well above the western.

Nature of the gypsum deposits

The gypsum forms regularly stratified beds which are usually heavy and range from several inches to 5 feet or so thick. The impure argillaceous gypsum is, however, rather thinly bedded, the individual layers being separated by shale intercalations. The strata are not, of course, absolutely continuous along the Salina belt, but have the shape of elongated lenses which succeed each other along the strike and dip, perhaps after intervals occupied only by the accompanying shale and limestone. The workable deposits are thus separated into more or less well defined areas, on the borders of which the gypsum diminishes or entirely disappears.

The lenticular form of the deposits is well illustrated by the area near Akron which has been fairly well delimited by exploration underground and by numerous test holes [*see* map facing p. 50]. The bed averages about 4 feet thick and extends for nearly 2 miles in an east-west direction before it thins out. On the north or outcrop side it apparently diminishes very slightly and then terminates abruptly, a feature which is due probably to removal of the gypsum by erosion. The extension of the bed on the dip has not been thoroughly explored, though the available evidences indicate a gradual thinning in that direction.

In surface exposures the beds may exhibit local modifications of the lenticular form. Several occurrences illustrative of such irregularities have been described and sketched by Hall[1] with considerable detail. Two of his sketches are reproduced herewith [fig. 3, 4]. In explanation of the features shown in figure 4, Hall expresses the

[1] Survey of the Fourth Geological District. 1843. p. 119 et seq.

opinion that they are attributable to the removal by underground waters of the shale along the contact which has caused it to subside and to fill in the hollows between the gypsum masses. He does not give, however, any explicit reasons for the peculiar shapes assumed by the gypsum and one might even conclude that he considered such masses to occur very generally throughout the Salina belt.

The significance of these irregular discontinuous deposits has been misinterpreted in some descriptions, owing to which the sedimentary origin of the gypsum seems to have been seriously questioned by geologists. There can be no reason to doubt that they are of superficial distribution and represent the remnants of former lenses of normal type partly dissolved away by ground waters. If followed along the dip of the strata, they would be found probably to lose their irregular form and merge into the usual bedded deposits. The solvent effect of ground waters upon the gypsum is shown in numerous places on the outcrop; the joint and bedding surfaces are often deeply pitted, and secondary veins of gypsum may be observed extending into the shales.

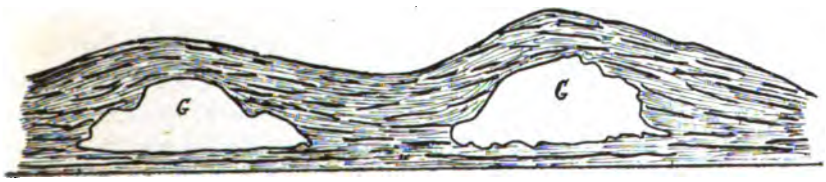

Fig. 3 Irregular bodies of gypsum resulting from solution of a once continuous bed. (After Hall)

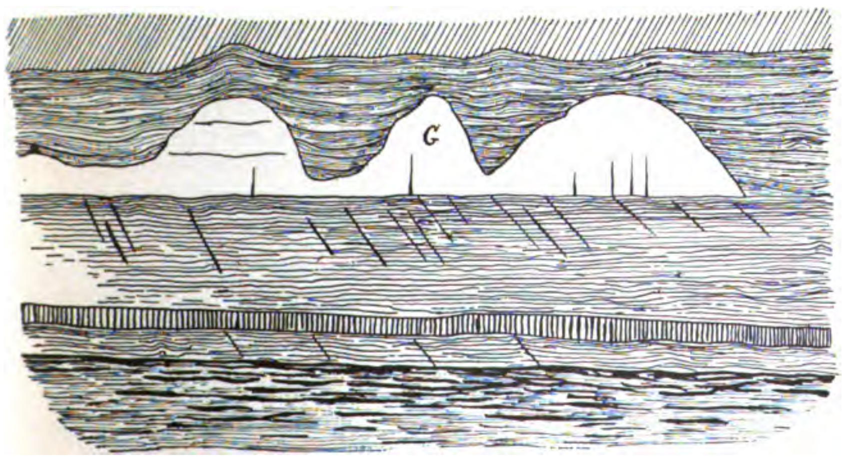

Fig. 4 Bed of gypsum partly dissolved away. (After Hall)

DETAILS OF THE DISTRIBUTION OF GYPSUM IN NEW YORK: WITH DESCRIPTION OF MINES, QUARRIES AND MANUFACTURING PLANTS

Herkimer county

The most easterly occurrence of gypsum that was ever worked commercially is a deposit in southeastern Herkimer county. It was discovered previous to 1837 in an adit run into the hillside on the James Crill farm in the western part of Starke township. The opening was intended to explore a supposed silver vein. The gypsum is said to have been found in a roundish mass and to have had a white color. Some 20 or 30 tons were removed by Mr Crill. Present interest is chiefly connected with its situation so far east and with the fact that it is described by Vanuxem as occurring in a white sandstone of Clinton age which at this point immediately underlies the Camillus shale and can be seen in outcrop a little north of the opening. It seems probable that the deposit is of secondary character, derived from scattered inclusions of gypsum in the shale above.

Oneida county

The Salina shales have a small areal distribution in Oneida county and there are no records to show that gypsum has ever been worked within its limits, though the occurrence of small deposits seems very likely, specially toward the western boundary of the county in Vernon, Augusta and Kirkland townships.

Madison county

The gypsum beds of Madison county, so far as known, all lie near the upper or southern part of the Salina outcrop in a belt running east and west across the northern portion of the county. The townships included are Lenox, Oneida, Lincoln, Sullivan, with a possible occurrence in the valley regions of northern Cazenovia, Fenner, Smithfield and Stockbridge townships.

The gypsum occurs in the form of lenses, pockets, or irregular masses in the Upper Salina shales, frequently immediately underlying beds of waterlime. The pockets are rarely very extensive, seldom exceeding 25 feet in length and a depth of 10 or 20 feet.

The gypsum consists of a mixture of clear selenite plates and a loose, earthy, dark colored mass consisting of clay and organic material. The selenite plates are rarely larger than 2 or 3 inches across and are so intermingled with the earth as to make the mass friable and easy of extraction. The clear, pure, nature of the

selenite gives to the beds an appearance of high quality which is at once dispelled by a glance at the analysis below which is based on an average sample taken from a 50-ton lot from the bed of Mr Duane Clock at Clockville, and analyzed by Prof. F. E. Englehardt.

Gypsum ($CaSO_4 . 2H_2O$)	70.6421
Calcium carbonate ($CaCO_3$)	6.9073
Magnesium carbonate ($MgCO_3$)	7.1891
Iron oxid (Fe_2O_3) / Aluminum oxid (Al_2O_3)	4.9200
Insoluble (SiO_2 etc.)	5 9000
Moisture and organic	4.4415

The quarrying and grinding of gypsum for agricultural uses have been carried on in the county from early times. In the first part of the 19th century it was a much more important industry than now. Some of the quarries then in operation were those of Cobb, Merrill and Wright along Cowaselon creek in the town of Lincoln (formerly Lenox); those of Judge Seeler and Mr Lawrence on Clockville creek; and the old Sullivan bed to the east and north of Chittenango which was worked during the Revolution and its plaster shipped as far as Philadelphia. Also the Van Valkenburgh quarry south of Chittenango, Bull's and Brown's quarries between Sullivan and Clockville, and doubtless many others were in operation about 1840. In recent years pockets of gypsum have also been worked intermittently at Hobokenville, where is situated the Tuttle quarry and mill, and about 1 mile south of Cottons where the mill and quarry owned by R. D. Button are located.

The gypsum bed at Clockville, now owned by Duane Clock, is as favorably situated as any in the county for extraction and shipment. The bed, some 100 feet long and 5 to 7 feet thick, outcrops along the Elmira, Cortland and Northern Railroad about ¼ mile northeast of the Clockville station, 200 feet north of the railroad bridge crossing the creek. Another bed outcrops just south of the bridge while the surrounding hills contain numerous other deposits. The gypsum is the typical friable admixture of selenite and impure gypseous clay. It is underlain by Salina shales and overlain by clay. It contains on the average about 70 to 75 per cent gypsum and can be easily and cheaply mined and loaded directly on cars.

About 5 miles farther west are gypsum beds owned by Cyrus Worlock and R. D. Button which are of similar character and are also easily accessible. Other deposits are found near the Erie canal, such as those between Chittenango and Sullivan. They are in many

cases very heavily topped with a shale and limestone cap which must be stripped in quarrying, since it appears too badly broken up to allow tunneling methods.

Owing to their somewhat irregular character and to their relatively low percentage of gypsum, the more inaccessible deposits in this region have little present value, while even the more favorably situated and larger lenses are of limited utility.

Onondaga county

The Salina shales outcrop in Onondaga county in an east-west belt varying in width from 10 to 12 miles. The lower beds, known as the Vernon red shales, outcrop in the northern portion in Lysander, Van Buren, Clay, Salina, Cicero and Manlius townships. They are described by Luther[1] as including many layers of green shales and mottled red and green shales. "The red color is, however, very pronounced, a strong brick-red; the green is a light but generally distinct pea-green. Some of the upper layers near the contact line are olive. Red is the predominating color in the lower beds, and green toward the top. The shale is very soft and clayey, crumbling into dust on exposure, if dry, or turning to clay, if wet. Some of the green and olive layers are fissile to a slight degree."

Overlying these shales and outcropping to the south are a series of peculiar, cellular, broken limestones containing hopper-shaped cavities, seams and irregular cavities. These are accompanied by dark gypsiferous or olive colored shales. This is supposed to be the horizon of the salt beds of the State and at the surface, along the outcrop, numerous salt springs were once abundant. Above this horizon and to the south lie the gypsum or Camillus shales. They occupy a belt 2½ to 3 miles in width and are bounded on the south by the ridge which is a prolongation of the Helderberg escarpment. They also extend in long tongues to the south through the escarpment in the valleys of Limestone, Butternut, Onondaga, Marcellus and Skaneateles creeks. The gypsum series consists of gray, drab or mottled shales with interstratified layers of fine-grained platten dolomite, and contains many thick beds of grayish to black gypsum and gypsiferous shale. Between the two chief gypsum masses, according to Luther,[2] there lies a 40 to 50 foot course of dolomite or clayey limestone, containing numerous cells and cavities and formerly known as "vermicular limerock." The gypsum beds

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[1] N. Y. State Geol. Rep't 15.1898. 1:250.
[2] *Ibid.* p. 264.

seem to be most persistent where overlain by the escarpment of Bertie waterlime, Cobleskill, Manlius and Onondaga limestones and for this reason are found mainly in the low hills capped by these limestones and along the stream valleys cutting through the escarpment.

The beds of massive gray gypsum occur beneath small hills between Fayetteville and Jamesville. The first area is a series of wooded hills ranging in hight from 40 to 100 feet. These lie 2 miles southwest of Fayetteville or 1 mile south or southeast of Lyndon, a station on the trolley line. They are capped by Helderberg limestone and the gypsum beds outcrop on the sides of the hills, forming a belt around each hill. The capping of resistant limestone seems to have served as a protection against the removal of the gypsum by percolating waters.

Clifford Miller quarry. This quarry is situated 1 mile directly south of Lyndon, to the east of the road. It has been worked from early times. It is also known as the Heard or Severance quarry. The gypsum bed is about 60 feet thick and consists of a number of alternating layers, varying in purity, color and grain, the individual layers having local names such as the "cap rock," the "9-foot," the "11-foot," etc. They range in color from very light drab in the cap rock to dark or almost black, and at times have a brownish color from the presence of iron. Despite its varied appearance the rock runs rather uniform in gypsum, and no attempt is made to sort the material in the quarry operations.

The gypsum here is overlain by 2 feet of marlite or weathered shale, followed by 5 feet of thinly bedded blue limestones (Bertie) then 15 or 20 feet of massive porous Cobleskill limestone full of cavities, with a varying thickness of glacial drift and soil as capping to the whole. The heavy mass of overburden becomes more troublesome as the quarry is carried farther into the hill and the stripping problem becomes a difficult one. The overlying marlite is usually blasted out until, by caving, the whole overburden falls into the quarry excavation and work is resumed on the new face of gypsum. Both hand and machine drills are employed. Black powder is used in blasting. The broken gypsum is loaded by hand into large 20-ton side dump wagons which are drawn from the quarry by a traction engine a distance of over 2 miles to the canal. The grade is mostly downhill and the road is in good condition. The installation of traction haulage is a new feature in the district and seems to be giving satisfaction. At the canal dock, the rock is dumped down a small embankment, and from there loaded by six

men into a steel bucket which is swung by a boom derrick to the canal boat and dumped. The gypsum is all shipped in crude state to Mr Miller's plant in New York city where plasters of various kinds are made.

Quarry of the National Wall Plaster Co. This quarry is situated south and west of the Miller quarry on the same knoll. The gypsum bed is continuous with that in the Miller quarry but is not quite so thick. The property includes about 15 acres underlain with gypsum. Quarrying is carried on intermittently and at present no work is being done. The overburden is similar to that of the other quarry but stripping is accomplished by excavating the gypsum in such a way as to undercut the limestone beds and the latter are then allowed to fall into the vacant space. The rock was formerly hauled to the canal and to the mill but the latter now stands idle. The equipment of the mill consists of a Sturtevant jaw crusher, a set of Hoagland rolls, Cummer kiln and cooling bin, two 10-ton kettles, and a buhrstone mill. The rock was first crushed, then passed through the Hoagland rolls which reduced it to the size of corn. A large quantity of it was shipped in that state to cement manufacturers. Some of this crushed rock was passed through the Cummer kiln at a temperature of 340° and shipped without grinding. Some was also ground in the buhrstone mill and calcined in the kettles. The future of this company is still an unsettled question.

Quarries at Fayetteville. To the east of these quarries are those of H. H. Lansing, now idle; and also idle quarries formerly owned by the Adamant Wall Plaster Co. and C. A. Snooks, but now controlled by Clifford Miller.

Large amounts of a similar grade of gypsum are found in all of these quarries and extending into the several hills. What is most needed at present is an outlet for shipping, such as would be furnished by a railway switch now being contemplated, or by aerial tramways or bucket carriers to the railroad or the canal. Another improved method, not yet introduced in the region, is mining by means of adit tunnels driven into the hillsides. This would obviate the necessity of closing down in bad weather and would do away with the expense now incurred in stripping.

At Fayetteville there are mills owned by Bangs & Gaynor and F. W. Sheedy. Each is equipped with jaw crusher, nipper and buhrstone mills, and grind gypsum. Their mineral is purchased from the neighboring quarries. The ground gypsum is sold as land plaster or to fertilizer companies.

LIST OF WORKINGS

1. Quarry,
2. Dock,
Clifford Miller Co.

3. Quarry,
4. Mill,
National Wall Plaster Co.

15. Abandoned workings.

9. Mill,
T. W. Sheedy

10. Mill,
Bangs & Gaynor

11. Mine

16. Mill,
Thomas Millen Co.

12. Mine

17. Mill,
E. B. Alvord Co.

Quarries at Jamesville. The second area in which active operations have been conducted is 2 miles north of Jamesville and east of the road leading to Dewitt (Orville). As in the other quarries the gypsum outcrops on the slope of a hill capped with Helderberg limestones. The north and west faces of this hill are abrupt slopes of which the lower portion is gypsum.

The quarry of Thomas Millen Co. is situated about ½ mile east of Reals station on the Jamesville trolley road. The gypsum is very similar to the Lyndon product and occurs in the same manner. It averages about 30 feet in thickness and is overlain by 50 feet of limestone. Until two years ago quarrying was carried on in the usual manner, but now the gypsum is excavated underground by means of a tunnel driven along a 6-foot layer of the best rock. In the fall of 1908 the workings extended 150 feet into the hill and 100 feet to the west. Much timbering is needed. The rock is drilled by electric drills, and the mine equipped with electric lights. The broken rock is loaded into 1-ton side dump metal cars which are hauled by wire cable from the working face to the entrance and up an inclined trestle, the cable being operated by a small engine and drum. Owing to the grade of the tunnel, the cars return to the face by gravity. From the cars the rock is dumped directly into 3-ton wagons and hauled by a team to the mill. The mill is situated about ½ mile north of Jamesville station, on the Delaware, Lackawanna & Western Railroad. No plaster of paris is made, the rock being shipped crude or after a preliminary crushing in a Butterworth & Lowe jaw crusher.

One half mile east of Millen's mine, on the same escarpment, is the mine of E. B. Alvord & Co. The gypsum is overlain by a few feet of thin shale, 15 feet of massive limestone and 20 feet of thinly bedded limestones. The company has recently begun mining the rock by means of a tunnel driven in an old quarry. A 5-foot layer is worked. The mine is lighted by electricity and the drills operated by the same power. No mine cars or track are used, but the wagons and horses are driven directly into the mines and to the working face. This necessitates wide gangways and large rooms, but no trouble is experienced with the roof. The mill of this company is situated at Jamesville, across the river from the post office. The power is furnished by a 70-horsepower turbine and the equipment consists of a jaw crusher, cracker and buhrstone mill as well as an unused kettle. The rock is sold crude, or with only preliminary crushing, to cement factories, or is ground in the buhrstone mill and sold as land plaster.

The gypsum bed appears at several places around the western flank of the hill where there are abandoned quarries, and in an abandoned tunnel near Fiddler's Green, a station on the Jamesville trolley line.

The close proximity of the railroad to this area is a feature that should bring about its greater development. The track is now only a mile from the mines, but there is a difficulty in the way of extending the switch because of the steep valley of Butternut creek.

Other quarries in Onondaga county. The deposits in other sections of the county are mainly of the pockety type and consist of mixtures of white gypsum, selenite flakes and crystals and fibrous gypsum veins with shale. As in Madison county, they rarely run over 10 feet in thickness and 25 feet in diameter. They are usually surrounded by shales and layers of impure limestone and occur both immediately under the Bertie waterlime or in the shales farther to the north.

In the eastern portion of the county the deposits are quite numerous in the town of Manlius, the hilly area between Chittenango, Mycenae and Fayetteville containing many such deposits. Many of the knolls have been opened up from time to time and the gypsum worked for land plaster, but at present no production is made. Westward there are no beds, with the exception of those in Dewitt township, already discussed, until the Onondaga valley is reached. The heavily glaciated area between Butternut creek and Syracuse probably contains gypsum beds, but as yet they are uncovered.

Two and a half miles south of Syracuse, A. E. Alvord formerly quarried a gypsum deposit. Vanuxem in his third annual report [p. 256] mentions the working of gypsum deposits along the railroad from Syracuse to Split Rock, and no doubt there are many small deposits in that section.

In the construction of the railroad from Syracuse to Auburn large quantities of gypsum were unearthed along the south side of Nine Mile creek between Camillus and Martisco (formerly Marcellus station). Thousands of tons of the material were taken out and the deposits attracted great attention. The gypsum bed consists of a mixture of limestone, shale and selenite or at times a whitish gypsum with wavy markings. At no part of the extensive cut was gypsum in pure masses observed, and if quarrying were undertaken the whole impure mass would need to be excavated and the percentage of gypsum would run low. The ease of mining and its accessibility to the railroad may render it of some value in the future. Other outcrops occur farther to the west, at Martisco.

Plate 3

Quarry face in gypsum, near Lyndon, Onondaga co.

One outcrop is at the prominent point or hill northwest of the station where a 10-foot layer has been quarried. The material is similar to that already described. Following south up a branch of Nine Mile creek another outcrop is seen just south of the station (Martisco) on the Marcellus Falls Railroad. It is about 20 feet in thickness and extends for some 150 feet along the road.

A few miles to the west the Auburn Railroad runs through a steep sided valley, and on either bank gypsum deposits are frequent. Probably the purest deposit of gypsum noted in the county was encountered in this ledge in an old quarry about half way between Halfway and Martisco. The quarry is now the property of Fred Chapman of Martisco and Monroe Hill of Elbridge. It is situated just off the road about ¼ mile south of the Auburn track on the face of an escarpment. The gypsum bed appears at an elevation of about 100 feet above the railroad. The quarry shows about 15 feet of gypsum in all, of which 4 feet is of much better grade than the average for Onondaga county. It is a grayish to white crystalline mass dotted with brown cleavable crystals and resembles the rock found at Oakfield, Akron and Garbutt. It is overlain by 20 feet of limestone, and the expense of stripping is the probable cause of idleness. No other outcrops were found in the vicinity, so that no idea of the extent of this stratum could be formed. It seems, however, a deposit well worth investigation, since a few test holes back on the ledge and along the outcrop would soon fix the boundaries of the good rock. Its favorable situation for working and its accessibility are evident. Some form of gravity tramway or aerial bucket tram could easily be constructed, a tunnel driven into the hillside, and the rock shipped on the Auburn road. The quarry was formerly owned by Abner Taylor and the rock was ground by Dwyer & Canear in their mill, long since abandoned.

The abundance of gypsum outcrops on the sides of the deep cut valleys between Camillus and Halfway would seem to indicate the former presence of a persistent and continuous gypsum bed over that region and it is probable that underlying the Helderberg limestones on most of the hills, gypsum beds would be found. From Halfway on to the western boundary of the county no gypsum deposits have been recorded, although there seems no reason to doubt their existence in that section.

Cayuga county

The area covered by Salina rocks in the county varies from 14 to 20 miles in width and falls within the towns of Conquest, Cato, Montezuma, Mentz, Brutus, Throop, Sennett, Springport and Aurelius. The Cobleskill limestone which forms the southern boundary of the area, immediately overlying the Salina, extends across the county as follows: Beginning at a point near Skaneateles falls the outcrop follows directly west to a point about a mile south of Sennett, where it crosses the New York Central tracks, turns southwest and crosses the northeastern corner of the city of Auburn, thence southwesterly to Hills Branch, and then south to Howland point and Frontenac island near Union Springs.

The topography of the northern portion of the Salina permits of but few outcrops. The area bordering the Seneca river is low and marshy while outcrops in other areas are completely obscured by a heavy covering of glacial drift, usually taking the form of drumlins. On this account very little is known as to the gypsum deposits in that portion of the county. About 1½ miles north of Throopsville, along the river, pockets of gypsum were worked in 1837, the owner being N. Marble of Port Byron. Other impure deposits have been reported in the vicinity of Montezuma.

Along the southern border of the Salina and immediately underlying the Salina waterlime and Cobleskill are the important gypsum beds of the county, in early times the most important in the State. These beds are exposed at three localities: in the town of Springport north of Union Springs; at Cayuga Junction, ½ mile east of Cross Roads station; and on the boundary of the township 1½ miles north of Cross Roads. The gypsum in these localities varies from 10 to 40 feet in thickness, and is of a gray or bluish color, firm and massive, with plates and veins of selenite coating some of the blocks or mixed with the more impure material. In a few places it is overlain by waterlime rock but usually has an immediate covering of glacial soil varying from a few feet to 25 feet in thickness. The occurrence, as well as the character of the rock, is very similar to that of Jamesville and Lyndon. The stratigraphy of the Union Springs region has received the close attention of many geologists and much has been written concerning it. The points involved seem to have no direct bearing, however, on the present treatise and will not be discussed.

In the early days many quarries were in operation in the Cayuga Junction area, 2 miles north of Union Springs (then Springport)

and the plaster was shipped by canal all over the country. Mr Yawger is quoted by Vanuxem as stating that plaster was used there as early as 1811 while by 1842 the quarries were producing 10,000 tons yearly, the price delivered by boat to Ithaca being $1.50 to $2 per ton. From Ithaca it was transported by the Ithaca-Owego Railway and Susquehanna river to points in Pennsylvania. In 1840 five quarries were in operation, owned by Richardson, Partenheimer, Cresis, Howland and Yawger, while the Cross Roads quarry was owned by Mr Thompson.

At the present time and for some years back the only active quarry has been that of the Cayuga Plaster Co., of which C. T. Backus of Union Springs is president. The mill and quarry of this company is at present leased and operated by the United States Gypsum Co. The mill is situated along the Ithaca branch of the Lehigh Valley Railroad, about 2 miles north of Union Springs at Cayuga Junction. It is equipped with a Sturtevant cracker and nipper and five buhrstone mills. The rock is sold in lump or ground form to cement factories and others; none is calcined. The quarry is situated about 1/8 mile back from the mill. The gypsum varies from 20 to 30 feet thick and is overlain by as much as 25 feet of glacial drift that contains many waterlime boulders. Stripping is effected by means of a steam shovel, and the earth is carried to a convenient dumping place at one side. The gypsum is worked at the present time by quarry methods and by means of a tunnel driven into the lower course of the gypsum. Steam drills are used and on the open face the rock is blasted off in benches. The tunnel has been only recently opened and extends but a few feet into the face. The rock is loaded on cars and transported to the mill on a narrow gage cable railway.

An analysis of the plaster as quarried in 1903 showed the presence of 80 per cent lime sulfate.

The future of this field depends upon the uses which can be found for rock of this grade. Transportation facilities are good, the deposits are large, and mining could be carried on cheaply. Although the cement firms at the present time are demanding, generally, a higher grade of gypsum, which is supplied by the beds of western New York, the low cost of production and the advantages for shipment are favorable to an increased development at Union Springs, and in time the once flourishing industry may be revived.

Another gypsum deposit was formerly worked at Cayuga Bridge (now Cayuga), the gypsum occurring both above and below the bridge. This deposit was in small pockets, however, and was soon abandoned for the better material south of it.

Seneca county

The area in Seneca county covered by the Salina shales lies in the townships of Junius and Tyre with a small outcrop in the town of Seneca Falls. In the two former townships outcrops are rare. The soft character of the Vernon and Camillus shales rendered them susceptible to speedy erosion during the glacial period and there has been formed a broad shallow east-west depression bounded by the more resistant limestones on the north and south. This area is heavily blanketed with glacial deposits, kames, drumlins etc. and is frequently marshy. It is almost devoid of rock exposures. Where the Seneca river has cut its channel through the Cobleskill and Bertie waterlimes, however, the Camillus shales have been uncovered and their gypsum masses exposed. The Camillus shale series according to Luther[1] "is composed in the lower part of thin dolomitic limestones and thin layers of soft shale and at the top has a bed of gypseous shale 35 feet thick, some parts of which are of sufficient purity to have, when pulverized, some economic value as land plaster and wall plaster. Gypsum was quarried about 1840 near Black brook west of Nichols corners and the bed has been penetrated in wells of that vicinity. It is not exposed along that stream now."

The exposures of gypsum along the Seneca river have been described by John Delafield,[2] as follows: "The greatest exposures of the rock are on the north bank, on the farm of Mr Frederick Swaby, and also on the ground of Mr Cady. The rock on Mr Swaby's farm was extensively worked at one period, and before he purchased the property; but, owing in some degree to the limited size of the beds, but chiefly to the neglect of the parties who worked the quarries, they are not productive. The difficulty seems to have arisen from the omission of separating the rock from the shales and marly limestone which surrounds it. . . The hight of the cutting is about 40 feet and the upper bed of rock, the drab colored limestone (*Bertic waterlime*) is covered by a few feet of soil; it is about 6 feet thick."

He speaks of the plaster as occurring in large unconnected masses in the shale, one being 15 feet high and 35 feet broad. Gypsum occurs on the south side of the river in the bluffs but is not exposed. It is again exposed farther east on the north side of the river at the railroad bridge; and it was uncovered on the south

[1] N. Y. State Mus. Bul. 128. 1909. p. 7.
[2] N. Y. State Agric. Soc. Trans. for 1850. 1851. 10:441–42.

side, in a cut made by the railroad company for the purpose of filling in low ground, the gypsum occurring in courses 4½ and 2½ feet in thickness and very accessible. At one time, as mentioned by Mr Delafield, the plaster industry along the Seneca river was an important one, and the output amounted to 5000 tons annually. It has been abandoned for a long period, however, and there is little prospect of its resumption. The deposits are all, no doubt, of the impure "mixed" type, while any that might be encountered under the drift of Junius or Tyre townships would require shaft mining and that too under unfavorable conditions such as wet ground and the like.

Wayne county

Only the northern or lower portion of the Salina shales outcrops in Wayne county and that only along the southern border in a belt averaging perhaps 6 miles wide. Although the contact between the Camillus and Vernon shales is not sharply defined, we may infer from the thickness of the Salina shales in the county that the exposed part lies below the Camillus and in the main perhaps below the horizon of the salt beds. Wells drilled in Clyde show the Salina to be 840 feet thick at that point, and at Alloway it is 580 feet thick.

Gypsum is said to be exposed at various places along the line of the canal and the New York Central Railroad. At Clyde it is found in wells at a depth of 25 feet, at Lyons at 40 feet, and at Palmyra at the same depth. Gypsum was at one time quarried at a point 2 miles west of Newark, where the railroad and canal pass between two hills. North of the canal, on lot 85 owned at that time by Winslow Heth, quarries were opened as early as 1832 and by 1839, 2000 to 3000 tons had been extracted. The gypsum is described by Hall[1] as being "mostly lamellar, transparent and of that variety which receives the local name of isinglass plaster." It was said to occur with varicolored gypseous marl and to have the form of "large rounded, irregular masses."

South of the canal was Blackmar's quarry which was worked at the same time and contained plaster of similar quality. Gypsum has also been quarried around Port Gibson [*see* descriptions under Ontario county] and undoubtedly many similar pockets underlie the area northeast of Port Gibson in Wayne county. Occurring as they do in the lower Vernon shales, the deposits are not likely to

[1] Geol. Rep't 4th Dist. (1837) 1838. p. 326.

prove of commercial value. The gypsum is all of the quality known as "mixed," i. e. consisting of selenite plates, reddish, granular and fibrous gypsum interstratified and seamed with clay shales, marlites, impure shaly gypsum, etc.; and it is found in small irregular deposits.

Ontario county

The Salina group is represented throughout the county by frequent exposures of Camillus shale, Bertie waterlime, while the overlying Cobleskill waterlime and in the eastern part of the county the Rondout waterlime are also encountered. Of these the Camillus shale is the only one of present interest and in it are found all the gypsum deposits. This shale occupies the entire northern portion of the county, and varies in width from 6 miles in the eastern portion to 2 miles in the western. In character it varies but little from its general type, a greenish or dark shale becoming light gray on exposure and containing interstratified platten dolomites at intervals. Where exposed, it frequently contains the pockety beds of gypsum so characteristic of the beds to the east. In the greater portion of the area, however, actual exposures are rare, owing to the heavy drift mantle.

Beginning in the eastern part of the county, the first exposures of gypsum are those brought to light by the Canandaigua outlet between Phelps and Gypsum. Of these the best grade of rock is represented by the beds of the Empire Plaster Co., owned by Mr. A. D. Miller of Phelps. Mr Miller's main quarry lies on the northern bank of the outlet 1 mile north-northeast of Phelps Junction, near the bridge. The rock is a gray, impure gypsum, heavily seamed with fibrous white gypsum varying from ¼ to 1½ inches in width. It occurs in masses of 100 up to 3500 tons in weight and is gotten out by blasting. The material is hauled by wagons to the mill, located near the bridge, 1 mile west on the outlet. This mill is equipped with a cracker, nipper and buhrstones and is run by water power. The mill has been idle for two years but formerly carried on an active business in land plaster.

Across the road from the mill is an abandoned quarry from which Mr Miller formerly extracted gypsum masses from 25 to 3000 tons in weight. In early times many mills were in operation in and around Phelps and Gypsum, and the annual production of land plaster in the early forties along the outlet was 6000 tons.

From Manchester on to Victor the Salina beds are heavily covered or swampy, and no gypsum has been reported although well

drilling may bring some to light. The various cuts made by the Ganargua creek northeast of Victor have uncovered several gypsum masses of the pockety type, and quarrying was at one time undertaken. A mill and quarry were operated on the C. M. Conover farm 1½ miles east of Victor on the north side of the creek. The gypsum, for its kind, was of good grade, 40 feet thick, and had a large sale for land plaster. The quarry has been idle for 15 years. In the later years of quarrying, stripping became such a troublesome feature (there is 30–40 feet of drift) that a tunnel was driven at the base of the hill, with a breast of 14 feet. Gypsum was also quarried at one time in the Goose Egg, an oval hill about 1¼ miles north of the Conover farm.

On the Conover farm there have been found by core drilling two layers of gypsum resembling in appearance that seen at Garbutt, Akron and Oakfield. This is the most easterly occurrence of such pure beds in the State and is, accordingly, of great interest. The series of core drill holes were put down in the flat area near Ganargua creek about two years ago under the supervision of Mr C. L. Tuttle; after going through 19 feet of soil and 16 feet of waterlimes, the first gypsum vein, 8 feet thick, was encountered. At 104 feet, a second seam was struck, its width being 6 feet thick. The cores were examined by the writers and the gypsum appeared to be of good quality, the lower vein being light colored and fine textured, resembling the Oakfield gypsum, while the upper one was less pure and dark colored, though firm and massive, resembling the Garbutt rock. An analysis of the material made on chips taken along the whole gypsum portion of the core shows 96 per cent gypsum according to Mr Tuttle. Calcining tests show the lower vein to burn and set to a whiter color. The Victor Gypsum Co., of which Mr C. L. Tuttle of Rochester is president, controls this deposit, having an option on the Clara Conover, the Eliza Conover and the Mark Gourley farms, in all amounting to 365 acres. Plans have been completed for a switch from the main line of the Lehigh Valley Railroad to the proposed shaft house, but the actual operations have been delayed for two years. If the deposit should prove extensive, a large industry could probably be established, since the Lehigh Valley Railroad passes right through the district and connects directly with the large portland cement factories of Pennsylvania.

The Lehigh Valley Portland Cement Co. attempted to locate gypsum on the hill nearby and it is stated that they struck 5 or 6 feet of medium grade gypsum but decided not to work it. Other

reports indicate that they simply drilled through the 40 feet of mixed gypsum on the hill and struck limestone, not going as deep as did Mr Tuttle. The Atlas Co. is also said to have drilled neighboring farms without success. Conflicting opinions as to the extent and value of these deposits, as well as a lack of information as to several well records, make it impossible to arrive at any definite conclusions concerning the deposits. Judging by the more western areas we feel sure, however, that deposits of good gypsum will be discovered along the line of the Lehigh Valley Railroad, both to the east and to the west. The Bertie waterlime which, exclusive of the surface soil and drift, is the surface rock of the region averages 40 feet in thickness, so that in prospecting for the gypsum, one might have to pass through a heavy drift mantle and perhaps the whole 40 feet of waterlime before encountering the Camillus shale in which the gypsum lies.

Irregular pockets of gypsum occur near Port Gibson and have been worked for land plaster for years but are no longer productive. The most recent working has been that of Mr Ezra Grinnell who owns a water-power plaster mill along the creek and who obtained his gypsum from an 18-foot deposit near the mill. The gypsum in the area is said to occur under beds of argillaceous limestone in low knolls and hillocks, in the form of flattened spheroidal masses. It is fine grained, compact and contains no selenite veins.

Livingston county

No gypsum beds have been recorded in the county, due to the fact probably that they are heavily covered with limestone. The northern border of the county is occupied by the drab colored limestone of the Bertie formation, which overlies the gypsum beds. The Garbutt and Wheatland gypsum bed lies at an elevation of about 570 feet A.T. With an assumed dip of 40 feet to the mile, a fair average inclination, the bed on the border of the county would lie at about 490 feet A.T., so that at a surface elevation of 600 feet the bed would be pierced at 110 feet. There is reason to believe, however, that in the region between Caledonia and Mumford and in the area north and northeast of Maxwell, the horizon of the gypsum approaches nearer to the surface. Though the prospect of finding gypsum within these regions seems good, it will require exploration with the drill to determine the matter definitely, since in all probability the beds are not absolutely continuous with the Camillus shale.

Monroe county

The Camillus shale crosses the county from east to west, outcropping in southern Perinton, northern Mendon, southern Henrietta, northern Rush, southern Riga and Chili, and the greater part of Wheatland townships. Its northern limit is uncertain owing to the heavy drift covering and to its merging gradually into the Vernon shale below. Its southern limit is the outcrop of Bertie waterlime beds.

The gypsum deposits of value seem to be limited strictly to the town of Wheatland in the southwestern corner of the county. Here the Bertie beds, underlain by gypseous shales and the gypsum layers, are exposed for a distance of several miles along Allen's creek between Garbutt and Mumford; while small gypsum deposits have been exploited along its banks as far west as Fort Hill in Genesee county. The Wheatland township deposits are among the most important of the State. The area at present worked occupies about 3 square miles.

The gypsum at present developed, occurs in two continuous layers below 40 or more feet of soil and waterlimes. The upper layer lies at a horizon above the level of the stream while the lower layer is probably at the stream's level. The upper layer varies in thickness from 5 feet to 7 or 8 feet, but rarely can good rock be obtained with a thickness of over 5½ feet. The second layer, or "second bottom" as it is locally termed, has been found in practically all the workings. It is separated from the upper layer by a hard, bluish limestone varying in thickness from 6 to 12 feet. The gypsum in this layer varies also from 5 to 7 or 8 feet in thickness and in some mines contains from 1 to 2 feet of whiter gypsum than that of the upper layer. Its general average would probably run about the same. At present, the upper layer alone is being developed, although the lower layer has been exposed and its qualities are known. The descriptions of the individual properties follow.

Empire Gypsum Co. This company owns the most eastern mill of the group, situated southeast of Garbutt station and east of the north-south highway. The mine is situated west of the road, entrance being made to it by a slightly inclined tunnel, opening on the road. The gypsum averages 5 feet, 5 inches in thickness of which the middle 2 feet appears to be of the best quality, and the lower 2 feet is harder. The layer is overlain by a good limestone roof and underlain by 10 feet of limestone, below which is a second gypsum bed not yet developed.

The labor employed in the mines is mainly Italian. Drilling done with hand auger drills, and blasting with dynamite. T workings extend about ¼ mile in a southwest direction and a based on a room-and-pillar method. The mine at present is light only by torches, but the management is considering the installati of electric haulage and lights. The rock is loaded on wooden mi cars and hauled by mules to the surface and then across the ro over a trestle to the mill. At the mill the rock is crushed with jaw crusher and then by one of the usual nippers. It then passe into a rotary drying cylinder, is dried and then ground in a Uni versal pulverizer, a unique method in New York gypsum mills After grinding, the dust is collected by a fan which saves screening the whole product. The remainder is screened on inclined shaking screens. The ground material is then calcined at a temperature of 280° to 350° in three 11-ton kettles with solid bottoms. Material calcined at this temperature is said to be "first settling" and is "greasier and smoother" than that calcined at a higher temperature. Some of the material is calcined at 450° or second settling, and is then sold to the Pittsburg Plate Glass Co. for bedding plate glass. The mixing room is equipped with two 5-compartment Broughton mixers; two 12-tube bagging machines and a fiber shredder of the type in which the log of wood is pivoted and the knives revolve against it. This machine is capable of grinding 2500 pounds per day. The fiber is blown by a blast of air into the bins, the aeration also separating the dust from the fibers and loosening the mass. The wood used is mainly willow and basswood. Some of the crude rock is shipped directly, being dumped from the mine cars on the trestle into the gondolas below; a switch runs directly under the trestle, from the Buffalo, Rochester & Pittsburg Railroad. This plant is superintended by Mr G. J. McEntyre.

Garbutt Gypsum Co. This company, one of the oldest in the district, has a mill west of the Empire mill on the west side of the road, and on the north bank of the creek. The mines are located about a mile southeast of the mill, on the top of the south bank of the creek, and are reached from the mill by the roads to the south and west. In former days entrance was had to the gypsum bed by a tunnel driven into the north face of the hill, but this has been abandoned and at present the bed is reached by two small shafts. One of these was sunk four years ago to a depth of 70 feet, and the other, 100 feet to the west, was sunk in October 1908 to the depth of 68 feet. The covering consists of 40 feet of soil and 22 feet of limestone, the gypsum layer being from 5 to

8 feet thick. The gypsum appears to be of remarkably good quality for the region and resembles the Genesee and Erie county rock. The purest, whitest layer occupies about 2 feet in the middle of the face. The new shaft, now worked, is a two-compartment shaft, one compartment being occupied by the stairway and the other by the bucket. Mining is carried on by two men in the mine, the rock being simply gophered out with little system and wheeled or carried to the shaft. Here it is loaded on a scoop or square bucket and hoisted to the surface by a cable and derrick operated by a small donkey engine. The bucket is swung around to the wagon and dumped or, in case the wagon is full, it must be dumped on a reserve pile and later loaded by hand on the wagon. Two men operate the engine and hoist.

The purity of this rock warrants a larger equipment and a more systematic, scientific mining and handling of the product. It is said that they mine all that can be handled in the mill. Further exploration ought to reveal similar deposits on nearby properties, and with better equipment and a mill location more easily accessible to the mine, it seems possible that the area south and west of the mine could be developed. If a way could be opened up to transport the rock down the slope to the north and west, either by gravity, railroad or areal tramway, and a mill be located along the railroad at a convenient point, an important economy could be effected.

The rock is now hauled by wagons over the road more than a mile to the mill. The mill is equipped with one 15-ton kettle, one Butterworth & Lowe nipper and cracker, a buhrstone mill for grinding the gypsum, and a Broughton mixer. Power is furnished by a steam engine. Originally water power was used and later that was supplemented by a gas engine. Calcining is carried on at 38° and to calcine a kettle takes about four hours.

Lycoming Calcining Co. The mines of this company are located west of the Garbutt mill on the south bank of Allen's creek. Previous to 1900 the bed at this point was worked by means of a vertical shaft on the top of the bank, but when the property was acquired in 1900 by the present company a tunnel was driven into the side of the creek bank about one half way up and after drifting some distance through "ashes" or shaly decomposed material, the firm "vein" was disclosed. The bed is now worked by three tunnels, the two nearest the trestle being connected, while the newer third tunnel will be connected with the others in six months' time. The bed of gypsum varies from 6 to 7 feet in

hight. The rock is a light gray to brown gypsum with thin fibrous gypsum veins running through it. The lower 2 feet are harder and of poorer quality. The mine has a good limestone roof, separated from the gypsum by a thin parting of shaly rock known as rotten rock. The second "bottom" or layer of gypsum is 12 to 15 feet below the first and is separated from it by limestones. It appears to be of a grade equal to the upper rock. The mining operations have been conducted systematically, with pillars left every 21 feet. The mine workings now extend about 2500 feet into the hill. Mine no. 1, or that nearest the trestle, is about worked out. The mines are equipped with electric lights. Drilling is done with new auger coal drills and blasting with low grade dynamite. The whole face of gypsum is utilized, with no sorting, but care is taken to so arrange the cars that the poor and good grades alternate at the mill. At present the ore is hauled in steel cars by mules to the scale house, and then strings of cars are hauled across a wooden trestle to the mill by a horse. At the time of our visit in August, tunnel no. 3 was being opened out at its mouth so as to permit of a straight-away switch being laid, and they were preparing to instal a system of electric haulage, to abandon mine no. 1 and haul the product of nos. 2 and 3 out of no. 3. Mine no. 3 is less troubled with water and contains the best quality of gypsum. The electric system will necessitate a new trestle over the creek to the mill. Waste rock in the mine is utilized in banking up the sides of the gangways and very little needs to be removed from the mine. In mine no. 1 a shaft has been sunk through the limestones to the lower layer, and enough of the gypsum removed to prove that it is of good quality. By lowering the floor of the no. 1 tunnel an incline could be built and the lower layer easily worked. Some such plan is under consideration at present. After crossing the trestle, the cars are drawn up an incline by cable to the second floor of the mill and automatically dumped. The rock passes through a Butterworth & Lowe cracker and nipper, there being two of each, and is thus ground to ½ inch. It is then elevated and fed by a screw feed into two Cummer kilns equipped with American automatic stokers and with a Bristol recording thermometer, which records on a paper in red ink the time and temperature. The dust is separated in the furnaces by an air blast, and is said to make a high grade of land plaster. From the kilns the steaming gypsum is carried by screw conveyors to the large bricked-in cooling bins where it is allowed to finish cooking for 24 hours or so. The kilns can each calcine about 11 tons an hour.

Plate 5

Plant of the Empire Gypsum Co., Garbutt

It is then ground by four vertical Sturtevant "rock emery" mills and is ready for mixing or for shipment as stucco.

The prepared wall plasters are mixed in the west end of the building by the Diamond Wall Plaster Co., the materials used being cottonwood fiber, hair, sand and stucco. One mixture contains two parts sand to one of stucco with a small proportion of hair and retarder. The sand is obtained from Wheatland Center, 2 miles west, between the farms of Frank Kingsbury and Albert Mudge. Before use it must be dried and screened.

The Sackett Wall Board Co. occupies a large building adjoining this plant on the north. The company manufactures the large thin slabs of plaster board used so extensively for interior walls. The stucco is obtained from the Lycoming mill. It is mixed with water and placed by special machinery between many sheets of paper and the whole rolled into a cardboardlike sheet which when dried becomes the plaster board.

Monarch Plaster Co. The next mill in order is that of the Monarch Plaster Co., a little over a mile west along the Buffalo, Rochester & Pittsburg Railroad. The mine and mill are situated just north of the creek and railroad track near the railway bridge. The mine consists of a tunnel driven into the hill to the north. Drilling is done by auger electric drills and the mine is lighted by electricity, power being furnished by a gasolene engine in the mine. The gypsum bed is 6 feet thick, but owing to poor quality the lower 2 feet is left as a floor and only 4 feet of gypsum extracted in the rooms. The cement companies, it is stated, do not care to purchase the bottom rock. The mine is dry and the roof solid so that large rooms can be made, and open spaces 30 feet square are frequent. Mule haulage is employed. Six feet below the bottom rock is a second layer of gypsum which is 6 feet in thickness, 1 foot of which is of exceptionally white gypsum. Nothing has as yet been done with this lower layer.

At present the cars are hauled up a slight incline from the mouth of the tunnel and the material dumped into a small jaw crusher and cracker and the crude crushed rock sold to cement manufacturers. The company is installing, however, a large up to date crushing plant, in which the cars can be drawn by a cable directly from the mine to a considerable hight above the track and the rock dumped into the largest of Sturtevant jaw crushers, and from it into the bin and thence through a chute into the cars. The power will be furnished by a gasolene engine. The steel scales will be placed in front of the chute at the loading place.

This company is said to control a larger tract of land south of the creek which may be worked at some future time. The product is all sold as 1 inch or ½ inch material to cement factories.

Consolidated Wheatland Land Plaster Co. A short distance west, along Allen's creek, is the property of the Consolidated Wheatland Land Plaster Co. The old mine consisted of a tunnel driven from the north bank of the stream; a 6-foot layer was mined and the product hauled across a bridge to the mill. During the past year, however, a shaft has been sunk a short distance southeast of the mill. The shaft is 35 feet deep and by it access is gained to the same 6-foot layer that is mined by the Monarch. As in the Monarch, the layer consists of 4 feet of gray streaked gypsum with 2 feet of "bottom" rock which is of lower grade. The mine cars are run on a platform hoist and are hoisted to the surface by a drum and engine overhead. They are then run over a track directly to the mill. There is also a lower layer 6 feet below, which is 6 feet thick and has a 1-foot white layer. In the mill the rock is crushed by a jaw crusher, ground in two 4-foot buhrstone mills, of Turkey Hill, Pa., stone, made by the Monroe Burr Co., and is then calcined. at 380° in two solid bottom kettles. The sales include crude crushed rock, land plaster, stucco and wall plaster, the latter made with patent retarder and purchased wood fiber from Massachusetts. Some of the stucco is sold to the Rock Board Co. who have a small plant nearby. The plant is operated by steam or water power, according to conditions.

Possible occurrences of gypsum elsewhere in Monroe county. The known deposits of gypsum in the region around Garbutt and Wheatland are largely controlled by the operating companies and a few other companies not now operating. Prospecting for new deposits must now be carried on south of the creek on the uplands. The beds here lie under a heavy covering of soil and rock, and would be found at a depth of from 50 to 100 feet.

Aside from the localities described, the gypsum beds have not been much explored in the county. To the north of Allen's creek, pockety impure gypsum has been found at Beulah, on the Harman farm near Belcoda and on the Rogers and McVean farms 1 mile north of Garbutt. In the Rogers farm the gypsum was found at a depth of 40 feet, being overlain by 27 feet of soil and 13 feet of limestone. On the McVean farm gypsum was at one time extracted from the hill by a tunnel, now abandoned, and from appearances there is a possibility of its future utilization. Gypsum was also encountered in a well on the farm of Mr Clapp in North

Plate 6

Shaft of the Garbutt Gypsum Co., Garbutt

Rush. In the region south of the outcrop, gypsum has been encountered in various wells at Mumford and Caledonia at 60 feet depth, and Mr Jenkins, a well driller of Scottsville, states that an apparently good belt of gypsum runs from Wheatland to Maxwell, 4 miles southeast and that it lies about 45 feet deep across the whole belt. He also states that gypsum was encountered in a well at the State Industrial School.

Opportunities for further prospecting are afforded along the northern boundary of the Bertie waterlime north of Mendon Center; in the area between Rush and North Rush; in the hilly region between Garbutt and Maxwell, and in the hills north and northwest of Mumford.

Genesee county

The northern half of the county is occupied entirely by the Salina shales, and as yet these have not been differentiated into the Vernon and Camillus shales. Succeeding the shales are the waterlime beds with their attendant gypsum bodies, while above and to the south the Onondaga limestones and underlying waterlime beds stretch across the county in a well marked escarpment, called locally the " ledge."

According to Hall[1] the shales in the center of the towns of Bergen, Byron, Elba and Alabama are gray or ash colored and contain thin seams of fibrous gypsum, selenite and occasionally small masses of granular gypsum. Succeeding the shales are a series of bluish, slaty and drab colored impure limestones which, he says, embrace large beds of gypsum. These gypsum deposits, so important in former days, are no longer quarried, and their location is almost forgotten. They have interest, however, as sources of supply for the future.

Near the eastern boundary of the county, gypsum beds have been uncovered on the banks of Allen's creek, and at one time large quantities of plaster were quarried near Fort Hill.

About 3 miles northeast of Fort Hill, or about midway between Fort Hill and South Byron, on lots 118, 144 and 182 large amounts of gypsum were formerly quarried. The deposit on lot 118, according to Hall, belonged to Mr Hughes and Mr Cash and was "a *white* gypsum free from seams and intermixture of clay." It was covered by a bluish limestone with shaly seams. On lots 144 and 182 the gypsum was "clay colored" and was overlain by a drab limestone containing species of Avicula. These quarries be-

[1] Geol. N. Y. pt 4. 1843. p. 464–65.

longed to Messrs Bannister, Collins and Clifford. The plaster sold at 50 cents a ton at the bed and for $3.50 a ton, ground. The three lots furnished in all almost 3000 tons annually.

The next locality mentioned in the early reports is that of Oakfield, or as Hall[1] says "Gypsum is also found in the western part of Elba, near the junction of the Pine Hill road with the Batavia-Lockport turnpike." Since western Elba is now Oakfield township, the locality mentioned must be in the vicinity of Oakfield. The masses were small and were 8 feet below the surface. They were never extensively quarried.

No further mention of gypsum localities in the county is found in literature until the records relating to the discovery of the large deposits at Oakfield and later at Indian Falls and Akron on the Erie county border.

The pioneer in the Oakfield district was Mr Olmstead who for some years previous to 1892 carried on a business in land plaster. In 1892 he installed a kettle, the first one in the State and began the manufacture of calcined plaster. For comparison with the present development of the Oakfield beds we quote the following from Merrill[2] in regard to the industry in 1893. Speaking of the two active shafts of Mr Olmstead, he says:

> The most easterly pit is worked by four men. The shaft is 8 by 12 and 31 feet deep. A former owner ran a tunnel to the north which is now closed up. There are two tunnels at present, one 75 feet long, the other 55 or 60 feet long. These are separated 80 or 85 feet at the ends. The 55-foot tunnel is at present being worked. The deposit is only about 4 feet thick, not so much as this in many places. The only timbering is a few short stulls. The rock is very much the whitest plaster seen in New York, and when ground is like flour. The material is loaded in flat cars running on a track made by laying stringers and nailing cross pieces and covering with hoop iron. This lessens the labor of handling and increases the output. At the bottom of the pit the material is loaded into an iron bucket fastened to an iron chain which is operated by a horse whim and derrick at the surface. . . The capacity of Mr Olmstead's pits is about 15 tons per day.

From this period on, the industry has shown rapid growth. The Olmstead property was purchased by the English Plaster Co., and a mill was erected and equipped with a Blake crusher, nipper and five kettles and five buhrstone mills. The Genesee Plaster Co. in 1901 erected a mill with three calcining kettles, and to this mill

[1] Geol. N. Y. pt 4. 1843. p. 464.
[2] N. Y. State Mus. Bul. 11, p. 77.

Plate 7

Entry to mine of Lycoming Calcining Co., Garbutt

Plate 8

Mill of Lycoming Calcining Co., Garbutt

there was later added the equipment of the Big Four Plaster Co. The entire equipment consisted of one Blake crusher, one nipper, eight buhrstone mills, four kettles, two shaking screens, one single mixer, one triple mixer and one sand drier. The Oakfield Plaster Co. at about the same time was operating three mines and a mill that contained one Blake crusher, two buhrstone mills, one bolter, and two kettles of 10-ton capacity.

At present the industry is in control of two firms, both of whom are working on a good sound basis.

United States Gypsum Co. This company, which owns gypsum mills and mines in several states, entered the Oakfield district about 1903 and bought up or leased the properties of a number of the former companies. The company abandoned all but one of the many shafts, consolidated the mill equipment and installed electric power.

The present mines and mill are situated about 1½ miles west of Oakfield on the West Shore Railroad. The mill formerly belonged to the Genesee Plaster Co. and has already been described. The company also operates the mill of the Oakfield Plaster Co. a short distance to the west. The mine shaft which is situated about ½ mile north of the mill is equipped with a two-compartment electric hoist. The rock is automatically dumped into large hoppers, is weighed and then falls into a steel lined storage bin from which it is loaded directly by chutes into large cars which are drawn by a locomotive to the mill.

Niagara Gypsum Co. The mill and mine of this company are situated ½ mile west of the United States Gypsum Co's plant, or 2 miles west of Oakfield Station, on the West Shore Railroad. The manager is Mr M. A. Reeb. The shaft at present operative is situated about ½ mile north of the mill. Entrance is made through a two-compartment shaft, 45 feet in depth. Transportation underground at present is by means of hand labor. An electric hoist raises the rock from the mine to a level above the switch, where the rock is either dumped directly into cars or on a supply pile. The gypsum is conveyed to the mill on cars drawn by a 12-ton electric locomotive. A second shaft nearer the mill has just been completed. This is 51 feet in depth and will ultimately connect with the other mine, when all the rock will be conveyed underground by electric haulage to the new shaft. Here an electric hoist will be installed, together with a crusher and cracker also electrically driven. At the mill the rock is crushed first by a large rotary cracker, elevated by a bucket elevator, passed through two

crackers and again elevated to the bins over the calciners. Fr the bins it passes into two large Cummer rotary calciners each w a capacity of 15 tons per hour. The dust from the calciners collected in overhead bins and with the finished product from t calciners is elevated and passes into the brick-inclosed cooling bi After remaining in these bins 24 hours the material is ground four Sturtevant rock emery mills. It is then elevated and ca ried to the mixing room in the west end of the building. This equipped with two three-compartment Broughton mixers, a larg stucco bin, a fiber machine and a hair picker. Power for the mi is furnished by a 300-horsepower Allis-Chalmers motor. The mil and mine are operated day and night with a capacity of 500 tons for each 24 hours.

Additional occurrences in Genesee county. West of Indian Falls and 8 miles west of Oakfield, gypsum outcrops along the banks of Tonawanda creek. The stream cuts down through the escarpment and exposes the limestones and the underlying gypsum beds. A 6-foot layer of gypsum is exposed along the creek from 1 to 2 miles west of Indian Falls and about 30 feet above the creek, while above it lies an 8-foot layer of a more impure and harder gypsum..

The deposits are included within the Indian Reservation; in 1901 the Standard Plaster Co. secured the mineral right to the whole tract and began mining operations. Tunnels were driven into the 6-foot layer, using Howell's twist drills and black powder. The rock mined was loaded on flat mine cars and pushed by hand to the tunnel entrance where the good gypsum was loaded on cars and the waste rock thrown on the dump. From the mines the rock was carried by a railroad switch to the main line of the West Shore near Alabama, the switch being 3 or 4 miles long. The rock was then sent to Black Rock where the company had a mill equipped with a gyratory crusher and screen, one Cummer calciner, one cooling bin and five Sturtevant emery mills. The power was electric. The mines are now completely abandoned. Underground water and the presence of mud pockets are said to have been the main difficulties in the way of success. Similar trouble is encountered in nearly all gypsum workings, and it seems plausible that the conditions in the latter respect at least would have improved with the extension of the tunnels for some distance under the hill. The beds could also be worked through shafts.

The known gypsum beds of the Akron district begin 2 miles west of this locality. These will be discussed under Erie county.

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It seems probable that large quantities of gypsum as yet uncovered must lie near the surface in Genesee county. They are likely to be found from Fort Hill westward through South Byron and Newkirk to Oakfield, north of the limestone escarpment; thence following the escarpment in a westerly direction to Alabama and southwesterly to Akron. There is also room for development to the south of the outcrop of the dolomites, but these areas constitute a reserve for the future after the exhaustion of the beds near the surface.

Erie county

Entering Erie county at a point 2 miles northeast of Akron the escarpment formed by the Onondaga limestone and underlying waterlimes passes through Akron southwesterly to Clarence, thence westward parallel to and ½ mile north of the Clarence-Williamsville road. It continues through Williamsville and follows rather closely the road from Williamsville to Buffalo. Within the city of Buffalo its limits are as follows:[1]

> It follows the general direction of Main street from the Almshouse to near the New York Central Railroad belt line at Rodney and Fillmore avenues. After crossing Main street, it passes near the corner of Oakwood and Woodward to Oakwood and Parkside and enters the park at the stone quarry, crossing from there into the cemetery at the corner of the iron fence near Agassiz place. From here it sweeps around in a curve to Scajaquada creek at Main street bridge and passes out of sight beneath the drift on the left bank, about 300 feet below the bridge.

Of the escarpment Bishop says: "The hydraulic limestone is usually visible at the base, or north side, of this escarpment as a stratum of variable thickness in the face of the cliff but occasionally forms a terrace ranging from a few feet to 200 yards in width and approximately parallel to the escarpment. This terrace is most conspicuous between Williamsville and the Buffalo city line."

Very few exposures of the Salina shales north of the escarpment are recorded. The area is very flat and uniformly drift-covered. A small outcrop on the southern end of Grand Island and an outcrop along the Canadian bank of the Niagara from near the International bridge to a point opposite Strawberry island show the Camillus shales to be "soft light gray or olive gypseous shales."[2] Borings would seem to indicate an absence of the Ver-

[1] Bishop, I. P. N. Y. State Geol. An. Rep't 15. 1895. p. 312.
[2] Luther, D. D. N. Y. State Mus. Bul. 99, p. 8.

non shales, and Luther places the entire thickness of Salina shales at 333 feet. The overlying Bertie waterlime has a thickness of 53 feet at the Buffalo Cement Co's quarry, while the Cobleskill above varies from 7 to 9 feet near Buffalo to 12 feet at Falkirk near Akron.

Although gypsum beds of good quality no doubt occur below the Bertie waterlime, no definite information can be obtained of such deposits with the exception of the important ones at Akron and those encountered in the wells of the Buffalo Cement Co. at Buffalo.

Many gas wells drilled in Buffalo and to the eastward along the escarpment report varying amounts of "gypseous shales," "gray and white gypsum," etc., but careful examination of such records fails to lead to any definite knowledge. They were all drilled by churn drills in search of *gas* not *gypsum*, and little dependence can be placed on the data relating to the latter, either as to its quality, thickness or its depth from the surface.

The occurrence of gypsum at Buffalo was well established by the work of the Buffalo Cement Co. described by Ashburner.[1]

The Buffalo Cement Co. drilled a series of wells near the Main street crossing of the belt line in search for gas. Well no. 1 was drilled to a depth of 490 feet 6 inches with a diamond drill. Well no. 2 was drilled 6 feet from well no. 1 with a 5⅝ jump drill to a depth of 1305 feet. The core of well no. 1 is in the possession of the Buffalo Academy of Natural Sciences. The record of no. 2 as given by Ashburner is as follows:

DEPTH Feet	MATERIAL
1–25	Shale and cement rock in thin streaks
25–30	Tolerably pure cement rock
30–43	Shale and cement rock in thin streaks
43–47	Pure white gypsum
47–49	Shale
49–61	White gypsum
61–62	Shale
62–66	White gypsum
66–73	Shale and gypsum, mottled
73–131	Drab colored shale with several layers of white gypsum, measuring 18 feet in all
131–33	Dark colored limestone
133–37	Shale and limestone
137–40	Dark colored compact shale
140–720	Gypsum and shale, mottled and in streaks
720–25	Limestone
725–60	Soft red shale
760–85	White solid quartzose sandstone, very hard
785–1305	Soft red shale

[1] Ashburner, C. A. Petroleum and Natural Gas in New York. Am. Inst. Min. Eng. Trans. 1888. 16:924–27.

Plate 10

Shaft of U. S. Gypsum Co., Oakfield

At 1305 feet the drill was stopped. Permanent water was struck at 43 feet; gas of fair quality as well as quantity, at 452 feet; salt water, leaving on evaporation about 12 per cent of salt, was found at 555 feet. A shaft 20 feet square, was sunk on the premises later, for the purpose of determining the feasibility of mining the gypsum, but the rush of water through the gypsum layer at 43-47 feet, was so strong that a pump with a capacity of 2000 gallons per minute failed to make any impression upon it, and the attempt was abandoned.

Since then no further effort to exploit the gypsum has been made, though by reason of its quality and situation it seems to offer an attractive field which would warrant more thorough investigation than has been given to it.

The Akron gypsum "basin," as it is locally termed, is situated northeast of the village of Akron or 20 miles west of Buffalo. The productive area lies south of the West Shore Railroad, with which connections are made by long switches.

The boundaries of the workable bed or beds of gypsum have been rather well defined by the sinking of various shafts and the putting down of a number of core drill holes. On the northern side the boundary seems to follow rather closely along the Bloomingdale road running northeast from Akron, beginning at a point a little west of the Akron Gypsum Co's shaft and running northeasterly about 2 miles. The drill holes put down by the various interested parties in the vicinity and an unsuccessful shaft north of the road on the Akron Gypsum Co's property indicate an abrupt termination of the gypsum deposit north of the road and a large amount of unconsolidated material. There is a possibility that this low lying area represents a channel formed during the glacial period and subsequently buried or filled up with glacial till, and that the scouring out of such a channel has robbed that area of large amounts of gypsum.

In width the basin ranges up to over a mile. The whole area could be represented as pear-shaped with the small end lying just west of the Akron Gypsum Co's shaft and the large end east of the American Gypsum Co's plant.

The southern boundary is the least well defined, since the beds extend on toward the south under the escarpment of Helderberg and Onondaga limestones, which rises to a hight of 100 feet above the low lying flat on which the plants and mines are situated. It is said that a test boring drilled through the limestones on the "ledge" directly south of the Akron Co's shaft gave but a foot of good gypsum, while two recent drillings made on the Newman

property along Murder creek just south of Akron showed the presence there of but a small amount of gypsum. These would seem to define the limits of the western end of the basin. The boundaries of the eastern end under the ledge south of the American Gypsum Co's shaft have received but little attention, and nothing could be learned concerning them. The bed of gypsum as mined consists of a 4 to 5-foot bed of light colored crystalline or granular gypsum. It is overlain by from 25 to 50 feet of thinly bedded impure limestones, and these in turn are rather heavily covered by a mantle of glacial clay varying from a few feet up to 25 feet in thickness. The section at the new (no. 2) shaft of the American Gypsum Co. is as follows:

MATERIAL	THICKNESS Feet	Inches
Drift clay	18	......
Rock (waterlime)	3	4
Clay	3	......
Rock (waterlime)	3	8
Clay, water-bearing	4	......
Rock (waterlime)	21	......
"Ashes"	......	4
Gypsum	1	......
Rock (waterlime)	2	......
Rock, roof (waterlime)	2	......
"Ashes"	......	8
Gypsum	4	......

Other sections in the vicinity are very similar, so that the above might be taken as typical. The clay beds below the drift are evidently a series of soft weathered shales and are frequently a serious source of annoyance to mining operations on account of the large amount of water they contain. They are often so thoroughly saturated with water as to be veritable "mud seams" of soft fluid clay. Above the main gypsum bed so called "ashes" (an impure shaly gypsum or a mixture of selenite and shale) and even more massive gypsum rock is found in small layers.

The acreage known to be underlain with gypsum is controlled mainly by three companies, the American Gypsum Co., the Akron Gypsum Co. and the United States Gypsum Co., of which the two companies first mentioned are engaged in the mining and milling industry, while the United States Gypsum Co. does not at present work its property. The whole field is comparatively new, the first development work having been done in 1903.

American Gypsum Co. This company operates a large crushing plant and mines 2½ miles northeast of Akron on the boundary line between Genesee and Erie counties, the lands on which it owns mineral rights being situated on both sides of the line. En-

Plate 11

Shaft of the Niagara Gypsum Co., Oakfield

Plate 12

Mill of the Niagara Gypsum Co., Oakfield

trance is had to the mine by means of a shaft 60 feet deep. This shaft is divided into three compartments, one 5 by 8 feet for air passage and stairway; one 6 by 8 feet for passenger elevator; and one 6 by 8 feet accommodating the bucket elevator. Mining is carried on underground much as in coal mines, the most approved methods being employed to secure economy and safety. The gang-

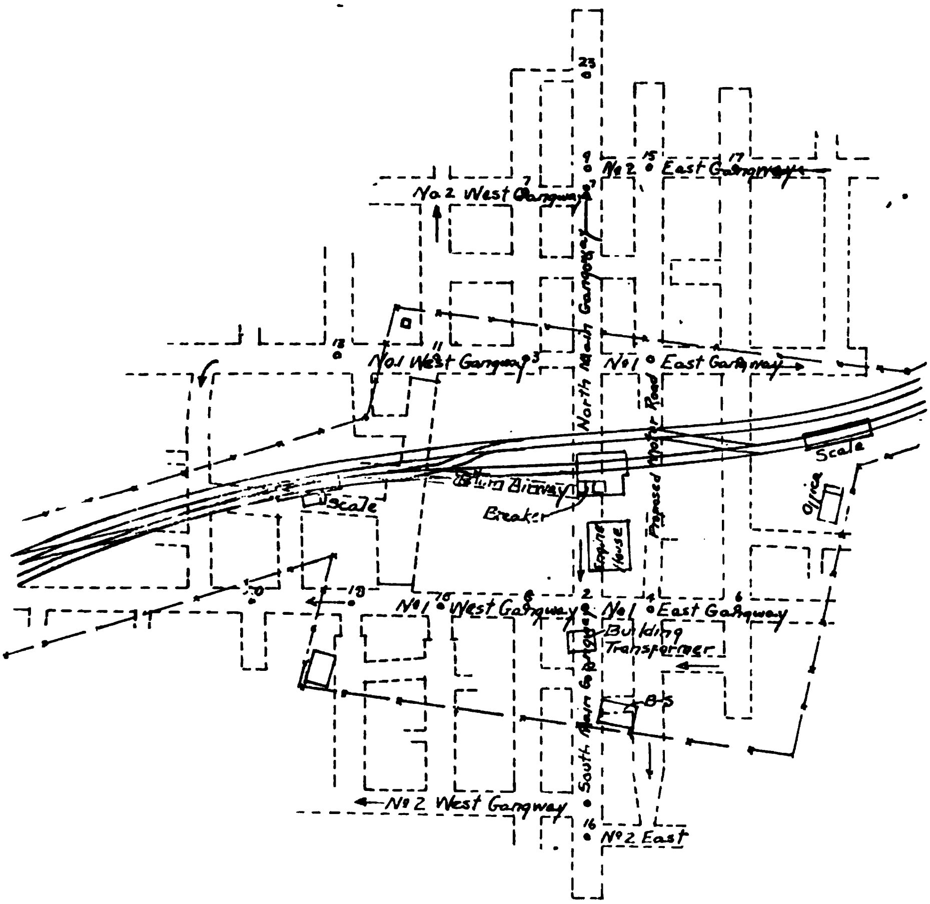


FIG. 5 Map of the surface plant and underground workings of the American Gypsum Co., Akron

ways are carried 6 feet high and are wide enough to admit of using the 2 feet of barren rock taken from below the gypsum bed for a supporting wall on either side of the gangway. The rooms are driven 24 feet wide by 300 feet long and their hight is simply the thickness of the vein, or 4 feet. Pillars 24 feet wide and alternately 40 or 60 feet long are left, each being separated by

a 20-foot cross cut. Good ventilation is afforded by the use of a 9-foot Buffalo Forge Co's exhaust fan operated by a 9½-horsepower motor. Excavation is done by contract, the miner buying his blasting materials and hiring his assistant who loads the cars. For drilling, Howell's no. 2 air drills are used. The air compressor is driven by an 85-horsepower motor. This compressor also furnishes power for the pump at the bottom of the shaft.

At present the cars are drawn from the rooms to the shaft by means of mules, but the managers are planning a system of electric haulage which will do away with all mule haulage in the gangways. The mine is well lighted by electric lights, well ventilated and kept dry. At the foot of the shaft the mine cars, holding about one long ton, are dumped by a side dump into a steel hopper which carries the rock to a point where it is picked up in the buckets of a vertical bucket elevator which hoists it to the mill overhead. This elevator is 110 feet long, contains 175 buckets and travels 80 feet per minute.

The rock is thus hoisted into the mill built directly over the shaft, is discharged into a 36-inch by 42-inch Jeffrey crusher where it is immediately crushed and then screened, all material over 1 inch in size being reelevated to the crusher. The crushed rock is then ready for shipment, the whole product being sold crude to cement factories. The dust arising from the grinding is carried by suction through pipes into a series of long vertical cloth sacks where the air escapes and the dust remains on the inner surface of the sack. At intervals the bags are shaken and the dust allowed to collect at the bottom. No use is being made of the dust at present, though it seems adapted for certain purposes by reason of its fineness and nearly pure white color.

All the machinery in both mine and mill is driven by electric power from Niagara Falls. The current furnished at 11,000 volts over a 3-phase 25-cycle line, is taken to a concrete transformer house where it is stepped down to 440 volts. It is then supplied to an 85-horsepower motor for an Ingersol-Rand compressor, to a 100-horsepower motor for the Jeffreys crusher and bucket conveyor, and to a 9½-horsepower motor driving the 9-foot ventilating fan. For the electric lighting, the current is passed through a 5-kilowatt transformer.

At the time the plant was visited in June 1909 a second shaft 64 feet deep had been sunk 1420 feet west of the working shaft, and preparations were under way to erect a breaker and extend the

Plate 13

Shaft and mill of the American Gypsum Co., Akron

railroad switch to that point. A sketch map of the underground workings is shown in figure 5, page 55.

There is a large flow of water into the workings, as in all the shafts of this field, but drainage is accomplished satisfactorily.

Akron Gypsum Co. The mill of this company is situated 1 mile northeast of Akron on the Bloomingdale road. The mine is situated southeast of the mill and is connected with it by a narrow gage gravity railroad. Mine and mill are comparatively new, active operations having begun in the fall of 1908. Mr George Ralph is manager. Entrance is had to the mine by a 6 by 12-foot shaft divided into two 6 by 6-foot compartments, and is 84 feet deep. Mining is conducted by the company itself and not under the contract system. The men are divided into gangs, each consisting of a machine man operating the drill and doing the blasting, a helper and two muckers. A large number of Indians from the nearby Tonawanda Reservation are employed in the mines and are giving very good satisfaction. Drilling is done by compressed air. The mining system in vogue is based on the old method of extraction by means of radiating gangways which center at the shaft. Pillars are left 30 feet apart and about 10 feet thick. The mine cars are pushed to the bottom of the shaft by hand, each man being required to push 30 cars a day and receiving a bonus for all additional cars. The gypsum bed as mined varies from 4½ to 5 feet thick, so that with the present methods of handling the cars, it is unnecessary to excavate any bottom rock. When first opened, 4000 gallons of water a minute were pumped from the shaft and although the flow has since been greatly reduced, a 4-inch pump is still kept in operation most of the time and the mine is quite wet. No forced ventilation is employed, a small airway on the east side of the shaft giving sufficient air. The mine cars brought to the bottom of the shaft are run directly on the platform of the hoist and are raised to the surface by a small drum hoist working in balance and driven by a steam engine. The cars are raised to a level above the ground and are dumped either directly into 2-ton steel cars on a gravity track or are dumped on the reserve pile. The cars are run by gravity to the mill and are hauled back in a string by a horse. At the mill which is situated just north of the Bloomingdale road the cars are hauled up an incline and dumped automatically into a Butterworth & Lowe jaw crusher. From this crusher the material passes directly to a "cracker" of the usual type, which reduces it to pieces no larger than hickory nuts. It is then elevated and distributed to

five 42-inch French buhrstones, where it is ground to a fine powder. This is then screened on 60-mesh brass shaking screens inclined at a 45° angle, and all material above 60-mesh is returned and reground. Screw conveyors carry the ground material to Butterworth & Lowe kettles, three in number. These have a capacity of 10 tons each and have nonsectional bottoms. They are fired by bituminous coal and use about a ton of coal a week, the calcining being carried to the point of second settling. The use of a blast of natural gas and compressed air in firing the kettles is being contemplated. The dust arising during calcining is caught in steam-filled chambers and returned to the kettles. From the kettles the plaster is conveyed to a large storage bin holding 900 tons. Some of this 60-mesh stucco is sold to outside companies for mixing, while some is reground on three 36-inch Munson buhrstone mills so that it is practically of 100-mesh and is thus sold for fine finishing plaster. The plant is equipped with two five-compartment Broughton mixers and makes various wall plasters with hair and wood fiber. They manufacture their own supply of wood fiber, obtaining their wood, mostly poplar, willow and basswood, from the neighboring farmers. The wood is shredded on a Hoover improved wood fiber machine, made at Perrysburg, O. The hair used is washed goat's hair and is purchased in bales. The sand is obtained from the company's own pit situated close by the mill. The wood fiber made is mixed in the following proportion: 1 ton stucco, 30 pounds wood fiber and 10 pounds retarder. The wall plaster containing hair is mixed in the proportion of 1 ton of stucco to 3 pounds of hair, when it is then ready for the sand. Raw ground gypsum from the buhrstones is also sold as land plaster to nurseries, experimental stations and to fertilizer firms. Power for the entire mill is furnished by three Bessemer gas engines no. 3146, speed 180 revolutions per minute, 125 horsepower, developing altogether 400 horsepower. A Rand compressor engine no. 10 also is operated by gas and furnishes compressed air for the mine and for a small machine used in dressing the buhrstones, each of which requires redressing about every three weeks. The natural gas used is furnished by the Akron Gas Co. through a direct pipe line from Alden. It comes in under a pressure of 125 pounds but is throttled down to 8 ounces for use. The gas costs 25 cents a thousand feet and about 40,000 feet a day are used, bringing the total cost up to $10 a day for fuel. The capacity of the mill is 300 tons of plaster a day.

Plate 14

Mill of the Akron Gypsum Co., Akron

CHARACTER OF THE GYPSUM IN NEW YORK; CHEMICAL ANALYSES

Within the long stretch of Salina strata from Madison to Erie county are included gypsum deposits of different physical and chemical characters. These variations are conditioned mainly by the relative proportions and nature of impurities present and to a lesser extent by the different conditions in which the gypsum itself is found.

While the deposits all belong to the general class of rock gypsum, from the descriptions of the individual deposits already given it is possible to distinguish two types that seem to be separate in their occurrence and may have originated under somewhat different conditions. The first of these is represented by the dense firm gypsum in which the impurities are evenly distributed so as to give the appearance of a more or less homogeneous mass. This is the usual rock gypsum which forms the basis of the calcined plaster industry in New York and in most places elsewhere. It consists of a ground mass of finely divided gypsum fibers or elongated acicular crystals in felted arrangement, with occasional larger individuals that stand out prominently by their brilliant cleavage surfaces. The other type is characterized by a loosely cemented aggregate of gypsum and shale, the two constituents being plainly discernible. The gypsum is usually in large crystals or crystal aggregates which by themselves are transparent and quite free from impurities. The deposits of this type are built up of successive thin layers of the selenite and shale. When the mass is exposed to the weather, the shale decomposes quickly and falls away from the gypsum so that in outcrops it may have the semblance of a high grade deposit. This type is known to the gypsum miners as " ashes," owing probably to the grayish color and powdery nature of the shale. It was quite extensively worked at one time for land plaster, but is evidently unsuitable for calcination.

The chemical composition of the gypsum found in different sections of the Salina outcrop is shown by the accompanying detailed analyses of samples which were collected during the recent field work. The samples represent the run-of-mine gypsum as now utilized, having been collected from the stock bins of the different mills. The analyses were made by George E. Willcomb.

	1	2	3	4	5	6
SiO_2	.51	1.03	.40	2.93	8.31	4.00
Al_2O_3	1.19	.41	2.97	1.92	4.53	1.74
Fe_2O_3	.79	1.27	.77	1.10	1.34	1.11
CaO	30.62	30.74	30.76	26.27	21.50	29.36
MgO	1.20	2.01	1.53	8.29	7.20	2.81
SO_3	43.59	42.39	43.78	33.83	30.47	35.79
CO_2	1.02	2.20	2.80	11.02	9.50	6.38
H_2O	20.52	18.19	17.53	14.87	14.53	17.93
	99.44	98.24	100.54	100.23	97.38	99.12
Gypsum calculated	93.74	91.27	94.26	72.84	65.49	77.06

1 Akron, Erie co.
2 Oakfield, Genesee co.
3 Oakfield, Genesee co.
4 Garbutt, Monroe co.
5 Lyndon, Onondaga co.
6 Lyndon, Onondaga co.

The following incomplete analyses are from the paper by Arthur L. Parsons,[1] with the exception of no. 8 which is taken from *The Mining and Quarry Industry of New York State for* 1907.[2]

	1	2	3	4	5	6	7	8
Gypsum	82.5	70.3	94.03	74.09	64.53	73.92	82.66	87.48
Silica & insol.	....	....	.....	6.05	11.17	4.62	3.86	3.34
Other matter	17.5	....	5.97	19.86	24.27	21.44	13.48	8.93

1 Wheatland, Monroe co. Under "other matter" are included $CaCO_3$ 1.75; $MgCO_3$ 3.6.
2 Wheatland, Monroe co. Analysis furnished by Iroquois Portland Cement Co.
3 Wheatland, Monroe co. Analysis furnished by Consolidated Wheatland Plaster Co.
4 Union Springs, Cayuga co.
5 Fayetteville, Onondaga co.
6 Fayetteville, Onondaga co.
7 Cottons, Madison co. "Other matter" includes Al_2O_3, Fe_2O_3 1.84; $CaCO_3$ 6.57; $MgCO_3$ 5.07.
8 Jamesville, Onondaga co. "Other matter" includes Al_2O_3, Fe_2O_3 2.92; $CaCO_3$ 3.33; $MgCO_3$ 2.69.

The analyses indicate that the gypsum content of the rock ranges between the general limits of 64 or 65 per cent and 95 per cent. The grade apparently improves toward the western end of the section, in Genesee and Erie counties, where the average is above 90 per cent. The rock in this part is also the lightest in color and yields nearly white plaster.

[1] N. Y. State Geol. An. Rep't 23. 1904.
[2] N. Y. State Mus. Bul. 120. 1907.

Plate 15

Rock gypsum showing banding and porphyritic crystals, Akron

The impurities of the rock are such as might be expected from the stratigraphic associations. The principal foreign ingredients are lime and magnesia carbonates, clay and quartz. The iron shown by the analyses is mostly present probably in the clay. The high percentage of magnesia in the rock of the eastern section is a striking feature, since it appears to be greatly in excess of the proportions found in dolomites. The presence of free carbonate is thus indicated.

PERMANENCE OF THE GYPSUM SUPPLY

There are no sufficient data on which to base an estimate of the available gypsum supply, but in view of the magnitude of the known deposits it would be a gratuitous task to attempt any formal calculation. The production of 4,000,000 or 5,000,000 tons in the past is insignificant as compared with the amount that still lies on the surface. It represents an equivalent of 40 or 50 acres of the thickest beds, such as are found in Onondaga and Cayuga counties, or about 400 acres of one of the 4-foot beds in the western section. The existing mines and quarries could maintain the present rate of production of 350,000 tons a year for an indefinite time. The extension of the workings in depth or the opening of additional areas on the outcrop will bring new supplies, as they are needed, into the zone of exploitation.

METHODS OF PROSPECTING AND EXPLOITING THE GYPSUM DEPOSITS

There are certain facts and inferences bearing upon the distribution of gypsum in the New York Salina beds that may be found useful in the conduct of exploratory work.

The main deposits occur in the upper Salina shales, and therefore their horizon of outcrop is near the southern border of the belt as traced on the map. Little is known of the character of the gypsum which belongs to the salt-bearing shales proper, and if represented anywhere in the present workings its identity has not been established.[1] The pockets of impure gypsum that are described from the eastern section of the belt quite likely occur at different horizons, since they are probably due to solution and redeposition of the gypsum rock, but they have little industrial importance.

[1] The deposits once worked at Port Gibson, Ontario co. seem to lie at a lower horizon than the other occurrences in the State and may be below the Camillus shale. The present investigation, however, did not uncover any definite evidence of their association with the rock salt series.

The best indicator of the position of the gypsum is the Bertie waterlime, which is found above the deposits in exposures along the sides of valleys or hills, or to the south of them when the surface is flat. It is much more resistant to erosion than the Salina shales, and together with the overlying limestones can often be traced in outcrop by the character of the topography. A very noticeable escarpment formed by the limestones extends across Erie, Genesee and Monroe counties, where it is known as the "ledge." The Salina shales occupy the plain between this escarpment and the parallel one to the north formed by the Niagaran limestones.

The absence of a protecting cover of limestones leaves the gypsum open to the attack of weathering agencies which may result in the partial or complete removal of surficial deposits. This seems to be the prevailing condition in the western section where the gypsum is very rarely seen in outcrop.

The sampling of gypsum must be conducted with care and intelligence. The successive layers or strata may show wide variations in purity, and it is generally better to sample each separately so that the series of analyses will reveal their individual character. Sometimes it may be found practicable to work only certain beds, leaving the poorer material in the roof or floor of the mines. In sampling the pocket deposits of friable shaly gypsum, close attention is required that the mass of fibers or crystals may not be unfairly sorted from the impurities.

The beds of rock gypsum can be explored to best advantage by core drilling. It is difficult in most cases to form an accurate estimate of their quality and thickness from exposures, except where these result from previous quarrying or mining operations. The sites of the drill holes should be selected with due allowance for weathering and solution of the gypsum near the surface. Besides affording accurate samples for analysis the cores will give valuable information as to the character and thickness of the covering.

The core drill is absolutely essential for exploration in Genesee and Erie counties, since the surface in that section is almost level and the deposits lie at depths of from 40 to 80 feet. Its advantage over the churn drill is so obvious and decisive that there can be little excuse for the continued use of the latter for such work. After the glacial material is once passed, no difficulty need be anticipated in securing cores of the limestones, shales and gypsum with a 2-inch diamond drill. As a rule the glacial drift of western

Plate 16

Selenite from shaly deposits, Onondaga county

New York can be penetrated without much trouble, as boulders are usually scattered and of no great size.

The extraction of gypsum by open cutting is necessarily confined to the eastern and central sections. The pocket deposits are worked only in a small way after the simple methods of early days. More systematic operations are carried on in connection with the rock gypsum of Onondaga and Cayuga counties. The beds are exposed along the sides of hills with a thickness of from 20 to 60 feet. The quarries at Lyndon, Jamesville and Union Springs are opened on such natural exposures. The overlying limestones and drift are stripped off or allowed to fall into the excavation left by the removal of the gypsum. As the work advances into the hill an increasing amount of overburden is encountered and in the course of time becomes a serious problem necessitating a change to underground mining or the abandonment of work altogether. There are many abandoned quarries around Fayetteville. At Union Springs the drift covering is stripped by steam shovels, and the material loaded on cars for removal to a dump. The breaking of the gypsum rock is effected by drilling and blasting with black powder or dynamite. Both hand and power drills of the percussion type are used in the quarries, the latter having perhaps less than the usual advantage over handwork on account of the soft nature of the material.

In the western section the gypsum is mined underground, and this practice has also been introduced recently in some of the quarries around Fayetteville to obviate the handling of the overburden. Entrance to the workings is had through an adit where the gypsum approaches sufficiently near the surface, otherwise a vertical shaft is used.

The main adits which serve for haulage are driven from 5 to 8 feet high and from 6 to 10 feet wide. The larger dimensions refer to the mines near Jamesville, where the gypsum is excavated in large rooms and removed by two-horse wagons that are loaded directly at the working face. With thin beds the rock is hauled out on mine cars attached to a cable. In some cases a foot or so of the floor rock is removed to provide the necessary head room, but this is generally unnecessary. The size of the rooms ranges up to 30 feet square. The overlying limestone makes a firm roof and little support is needed in addition to that given by the pillars; timbering or backing is only rarely necessary.

The mines at Akron and Oakfield, as well as those of the Consolidated Wheatland Co. at Wheatland and the Garbutt Gypsum Co. at Garbutt are entered through vertical shafts from 50 to 70 feet deep. The shafts have either two or three compartments, one of which serves for a ladder and airway. The underground workings follow the room and pillar system but are more regularly planned than these of the adit mines and are based on accurate surveys. The early methods of extending the drifts radiately from the shaft or in a haphazard manner are no longer pursued to any extent. The mines are often electrically lighted, ventilated by forced draft and when necessary are drained by pumps which raise the water from a sump at the shaft bottom. Gas, electricity and steam are used for power purposes, the former being supplied from the natural gas belt of western New York. Electric locomotives have been recently introduced for underground haulage, but in most mines the cars are either pushed by hand or drawn by mules. The hoisting is accomplished in various ways. At the Garbutt mine a derrick and boom raise the rock which is loaded into a metal scoop. The American Gypsum Co. has installed at Akron a bucket elevator. Single and balanced platform hoists which raise the gypsum in the mine cars are most generally employed.

The rock is broken by drilling and blasting. Auger drills are used in some mines and percussion drills in others, the former being employed when the rock is sufficiently soft. With hard or tough rock they are apt to become heated and to bind in the holes. Some companies prefer to let the mining on contract, while others maintain the wage system. The miners represent all nationalities but are mainly from southern Europe. A few Indians from the New York reservations are employed.

The mines are usually connected with the milling plants by tracks. In the Fayetteville district, however, the rock is teamed, except in one case where a traction engine is used to draw a 20-ton wagon, and the haulage is here an important item of the working costs. Much of the output of this section is shipped in lumps or ground form to cement and plaster mills outside the district.

ORIGIN OF GYPSUM

General principles and theories

Gypsum is formed by the combination of sulfuric acid with lime in the presence of water. The sulfuric acid need not necessarily be in free state, since almost any soluble sulfate may react upon lime

Plate 17

Satin spar in veins formed by secondary deposition in shale, Ontario county

minerals, specially the carbonates, to produce an interchange of bases. Wherever a source of sulfuric acid exists in nature, the formation of gypsum may be expected under ordinary circumstances, as the other essentials are nearly always at hand.

The derivation of sulfuric acid can be traced most commonly to the oxidation of the sulfur occurring in metallic sulfids. The iron sulfids — pyrite, marcasite and pyrrhotite — are particularly widespread both as rock-forming minerals and in ores. When exposed to atmospheric influences they are subject to rapid decomposition, yielding such compounds as hydrogen sulfid, sulfurous and sulfuric acids, ferrous sulfate and iron oxids. The presence of hydrogen sulfid in the spring waters that issue from the shales and sandstones of western New York is an illustration of the decomposition of iron sulfids which are disseminated in the shales. In the Oak Orchard spring at Byron, Genesee co. sulfuric acid of similar derivation exists both free and combined with lime, magnesia and the alkalis. Another source of the acid is from the decay of organic matter, which yields hydrogen sulfid in the first instance. This gas, as well as sulfur dioxid, is also given off by volcanos, fumaroles and hot springs, and gypsum is frequently deposited near their vents by the action of the acid vapors and waters upon lime minerals.

With the supply of sulfuric acid that is made available in these ways the formation of gypsum takes place very generally throughout the zone of weathering and ground-water circulations. Under some conditions the gypsum may accumulate directly in sufficient amount perhaps to have economic importance, as when acid solutions from the decomposition of pyrite come in contact with beds of limestone. But more generally it is carried in solution until the waters reach the surface and are concentrated by evaporation. Though gypsum dissolves rather slowly in pure water, its solubility is greatly increased in the presence of salts of the alkalis, specially sodium chlorid, so that sea water for example is a much better solvent than fresh water. It is by concentration of the surface waters held in some inland basin, lake, or arm of the ocean that the valuable deposits of gypsum are usually formed.

Deposition of gypsum from sea water. The deposits that result from the evaporation of sea water have been investigated by J. Usiglio, Van't Hoff and others. Usiglio in 1849 carried out a series of laboratory experiments which outline very well the general conditions of their formation, though his results have been amended in some respects by the later works of Van't Hoff and his associates. The experiments were based on samples of water taken

from the Mediterranean, which has a slightly higher content of solid matter than the open ocean, but which does not differ noticeably in the relative proportions of the several ingredients.

By evaporation of the water, which at the start had a density of 1.02, no marked deposition took place until the specific gravity of 1.05 was reached, when the volume had been reduced to 53 per cent of the original. Between this density and that of 1.13, the iron oxid and calcium carbonate were precipitated. Then, with a volume of only 19 per cent of the original, the solution began to deposit gypsum which continued to come down until the density reached 1.26. At a density of 1.214, when only 9.5 per cent of the solution remained, salt was deposited along with magnesium sulfate and chlorid. Further concentration brought down the more soluble salts in variable order, but sufficient details have been given for the present purpose.

The sequence of deposits from sea waters accordingly is first limestone and ferric oxid, next gypsum, and then salt and magnesium compounds. Gypsum is precipitated when 81 per cent of the water is evaporated and salt when a little over 90 per cent is removed.

The formation of gypsum beds in association with limestones and salt deposits is thus a simple process. But the evaporation of a relatively shallow lake or an arm of the sea alone would scarcely afford any considerable thickness of gypsum. Of the total solid matter in sea water, amounting to 3.5 parts in 100, only about 3.6 per cent consists of calcium sulfate. The extensive accumulations of salt and gypsum are to be explained, probably, by some such method as that advocated by Ochsenius. According to his theory the deposition occurred in nearly inclosed arms of the sea or lagoons. If a bay or lagoon is connected with the sea by a narrow and shallow channel, evaporation will cause the denser brine formed at the surface to sink and concentrate at the bottom while its diffusion will be prevented by the shallow opening seaward. Surface currents may enter from the sea, however, to maintain an equilibrium with evaporation. Provided there is little land drainage in the bay, the salinity of the water will increase until saturated, and deposition of the constituents will then occur in regular sequence. The process may be interrupted of course at any time by an unusual influx of water, or there may be periodic fluctuations of supply so as to produce an alternating series of deposits. That this method of concentration affords an explanation for many of the salt and gypsum beds is made probable by the fact that there are present day examples of its operation. Some of the bays on

the shores of the Caspian sea are now depositing salts, while the waters of Kharaboghaz, which are almost shut off from the sea by long spits that leave only a shallow channel between them, are in process of concentration and are fed by a surface current that is estimated to bring 350,000 tons of salt a day into the gulf.

According to this theory the evaporating basin is in effect a continuous salt pan and the thickness of the deposits that might be formed is limited only by its depth.

Formation by conversion of limestone in place. Where ground waters are supplied more or less constantly with available sulfuric acid, from pyritic shales for example, it is not improbable that they may convert large masses of limestone into gypsum during the course of time. The gypsum would retain perhaps the bedded structures of the limestone and would thus closely resemble the deposits from sea water. Just what importance is to be placed upon this method in relation to stratified deposits in general can not be stated, though some geologists have advocated its application to extensive occurrences, including those of New York State.

There is no doubt that this process operates in a small way. Scattered masses and crystals of gypsum formed by the reaction of acid solutions upon lime are found in the clay beds along the Hudson river. The indurated shales upon which the clays rest are impregnated with pyrite, which affords a source of sulfuric acid, while the clays themselves contain lime carbonate to the amount of several per cent. The gypsum is often well crystallized in detached individuals but has no economic value.

Gypsum deposited by ground waters. Ground waters holding calcium sulfate in solution may come to rest in joints, fissures or other openings in rocks, where evaporation may bring them to the point of saturation. The gypsum usually separates in the form of selenite or in the fibrous aggregate known as satin spar. The gypsum strata with their inclosing rocks are frequently veined and seamed by such secondary deposits. The cavities thus filled may have been very narrow at first, but were widened gradually by solution and possibly as well by the expansive force of the growing crystals. The force of crystallization is regarded by some geologists as an important factor in the formation of cavities occupied by minerals deposited from solution. Though its magnitude is not definitely established, it is considered in general to be measurable by the crushing strength of the minerals themselves. If such be the case, it is apparent that large masses of gypsum might be built

up within cavities of originally small compass, such as joints and the openings along bedding planes.

An example of the accumulation of salt and gypsum by the work of ground waters is found according to G. D. Harris[1] in the so called "Five Islands" or "Salt Islands" of Louisiana which rise as dome-shaped hills above the low coastal plain of the gulf. The domes are not due apparently to differential erosion but have been actually uplifted *en masse,* so that the strata dip away from their centers on all sides only to become horizontal as the plain level is reached. Their uplift has been ascribed previously to different agencies, including gas pressure, water under a great head, and to deep seated igneous masses which are working toward the surface. Harris finds that the domes occur at the intersections of master faults and thinks the faults have served as channels for the ascension of saline waters from great depths. With temperatures corresponding to their source in the interior at the start the waters would rise throughout the faulted strata and be compelled to precipitate their salts as they become cooler on their way. The solvent power of water for sodium chlorid decreases most rapidly between the temperature of 180° and that of 120° C. so that the precipitation of this salt would take place in greatest amount at considerable depths. The tendency therefore is to form a cone which, slender at first and pressing against the surrounding strata, would grow broader and longer by deposition at the base. The force of crystallization, it is thought, might move the mass upward spreading out the strata on all sides. With the deposition of salt the power of holding calcium sulfate in solution increases until the salinity is reduced to about 14 per cent, after which it rapidly decreases. Cooling of the solution down to about 40° C. also increases the solubility. The formation of gypsum would take place accordingly near the surface, and it is noted that the gypsum of Louisiana and Texas usually occurs above the salt.

This hypothesis involves a striking, if not a novel, application of the force of crystallization to the origin of such deposits. It seems, however, to meet the peculiar conditions that surround the occurrence of salt and gypsum in the gulf region (as well as in a few localities elsewhere) conditions which are difficultly explainable by the more common method of deposition from sea water. While there is, thus, much in its favor from a geologic standpoint, there is also need of more knowledge of the physical principle on which its validity ultimately depends.

[1] Econ. Geol. 1909. 4:12.

Mode of origin applicable to the New York deposits

There is no doubt that the gypsum of the Salina beds has been deposited by evaporation of surface waters and is an integral part of the stratified succession. This view is advocated or tacitly implied in most descriptions of the New York deposits that have already been published, though it has not escaped criticism. The evidences which form the application of this method to the exclusion of other theories may be summarized under the following heads:

1 Form and structure of deposits
2 Associations of the gypsum
3 Biologic conditions in Salina time

1 The occurrence of the gypsum in thin lenses which are of the same degree of continuity as the inclosing strata indicates an accumulation concordant with the salt, shales and limestone of the Salina. The lenses, in most instances at least, thin out very gradually, showing only moderate changes of thickness as they are traced from place to place and few irregularities not common to sediments in general. If the gypsum were formed by the reaction of acid waters upon limestone, variations in form like those found in replacement deposits of metallic minerals would be expected. The type of deposits in which the gypsum occurs as nodular masses with a thickness nearly equal to the horizontal dimensions — as figured by Hall and represented in Dana's *Manual* — is certainly the exception and not the rule and is the result probably of solution of the larger masses by underground waters. Such deposits are illustrated in figures 3 and 4 on page 25.

The undisturbed condition of the beds as generally observed is also against any theory of secondary deposition either by reaction upon limestone or by precipitation from ground waters. The change from limestone to gypsum involves an increase of 90 per cent in the volume, which would hardly occur without general disturbance of the adjacent strata. The beds, also, are not faulted or fractured so as to permit the easy circulation of waters in vertical direction.

2 The close relation of the gypsum to the salt deposits is such as would be expected from the evaporation of sea water. While the fact that the salt underlies the main gypsum beds, whereas the reverse is the natural order, seems to controvert this view, an explanation for it may be found without recourse to extraordinary conditions of evaporation and supply of the sea waters. If the

waters of that time held approximately the same relative proportions of salts in solution as the ocean of the present day, their evaporation would afford one part gypsum to something over 20 of salt. As gypsum occurs interbedded with the salt and probably distributed more or less through the Vernon shale below the latter, this relative amount may well be present in its normal order. The relations indicate, however, that the process of evaporation while the first gypsum and salt were laid down was subject to frequent vicissitudes from the influx of new supplies of sea water into the basins. After the salt had been precipitated by repeated evaporations the process was suspended for a time, during which the basins were probably invaded by land drainage and shales were accumulated in considerable thickness. A renewal of the early conditions with a fresh supply of sea water started the precipitation of gypsum again, but this time the process was not continued long enough apparently to bring down salt, or if it were precipitated it was redissolved before the overlying strata were formed.

Both the salt and main gypsum beds maintain a constant horizon throughout their extent. The main gypsum beds are found only in the Camillus shale and are generally limited to the upper section. In the western part of the State they are capped by limestone which shows no evidence of alteration by ground waters, and there are layers of unchanged limestone intercalated in the shale. There seems to be no sufficient explanation for any selective action on the part of the limestone whereby certain beds were more prone to alteration than others.

3 In the discussion of the stratigraphy of the Salina stage it was noted that the variations in the character of the strata are accompanied by marked fluctuations in the abundance of fossil remains. The preceding Niagara stage is characterized by a fairly prolific and varied fauna which has, however, a peculiar development that is connected by paleontologists with changes of physical surroundings. The Pittsford shale at the base of the Salina holds a very different fauna that is characterized by eurypterids. Throughout the succeeding intervals represented by the Vernon shale, salt and Camillus shales, there is little or nothing to be found in the way of fossil remains, and only with the Bertie waterlime, at the close of the Salina, do they reappear and are then represented by an assemblage related to that of the Pittsford shale. The lack of fossils in the gypsum beds may be explainable, perhaps, as the result of solution and breaking down of the strata by underground circulations, but this theory fails to account for their absence in the shales and un-

changed limestones which aggregate many hundreds of feet in thickness. This circumstance as well as the other facts regarding the fauna of Salina time becomes intelligible, however, when connected with the vicissitudes that life must encounter in sea waters of fluctuating salinity.

PROPERTIES OF GYPSUM AND THEORY OF ITS TRANSFORMATION TO PLASTERS

The composition and peculiar properties of gypsum have been the subject of frequent study by chemists since the development of exact methods of analysis. A brief review of the more important investigations will serve to show the intricate nature of the problems encountered and assist their explanation in the light of recent researches, so far as they may have been solved.

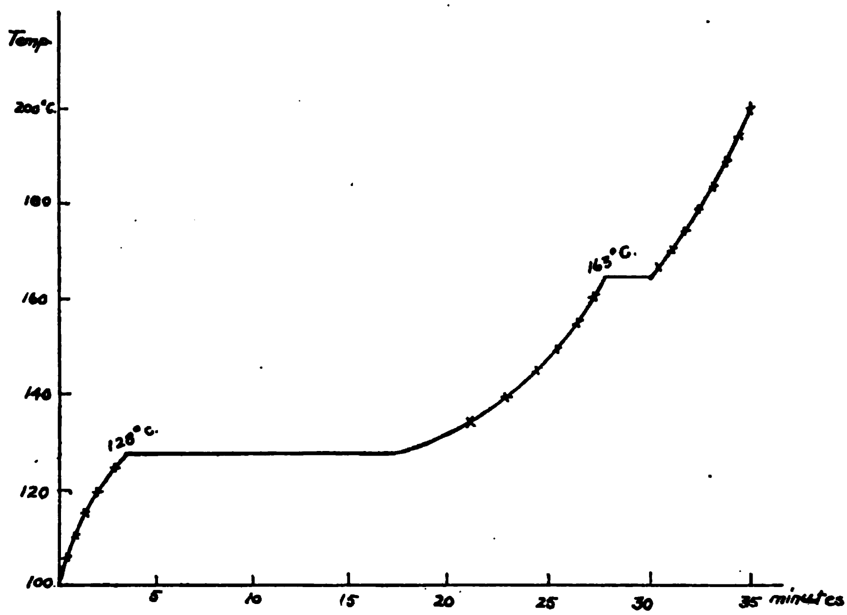
We are indebted to Lavoisier for the first definite data on the composition of gypsum.[1] He dissolved the mineral in water and found that its solubility was about one part by weight in 500 parts water. From the solution he was able to crystallize the gypsum out, and he therefore considered the mineral to be a chemical salt. Furthermore he determined the nature of the acid and base, as well as the presence of water of crystallization. By experiment it was found that the cooking of gypsum produced no new compound but simply drove off the water. In Lavoisier's opinion all of the combined water disappeared in the process, though he seems to have been familiar with the fact that commercial plaster of paris contained a small amount of moisture; consequently he was at loss to understand why plaster heated to a higher temperature than customary should be deprived of setting qualities.

Payen,[2] in 1830 found that gypsum heated at 80° C. in a current of dry air or 115° C. in a closed space "began to lose very slowly a part of its water of crystallization. This drying proceeds very rapidly as the temperature is raised, but beyond a certain point (200° C.) an important modification takes place. The sulfate of lime hydrates with difficulty, and when heated at 300–400° C. loses all power to take up water of crystallization."

In 1840 Berthier[3] showed that, contrary to the belief of Lavoisier and others, calcined plaster contained from 3 to 8 per cent of water, and his results were confirmed later by Landrin.

[1] Acad. des Sci. Compt. Rend. Paris. 1765.
[2] Chimie Industrielle 1830 and Précis de Chimie Industrielle. Paris. 1851. ed. 2. p. 301.
[3] Ann. des Mines, 1840, ser. 3, 19:655.
[4] Ann. de Chimie et de Phys. ser. 5, 3:440.

It remained for Le Chatelier[1] to make the first accurate observations in relation to the changes involved by the calcination of gypsum. He noted that calcined plaster contained some 7 per cent water, as shown by his own experiments and by analyses made in L'Ecole des Ponts et Chausses. "M. Debray has demonstrated," says Le Chatelier, "that different hydrates of the same salt are characterized by different tensions of dissociation, greater as the proportion of water is greater. This results in the fact that the



G. 6 Temperature gradient for the decomposition of gypsum. (After Davis)

temperature of decomposition of the different hydrates, under a given pressure will not be the same. In studying from this view the decomposition of gypsum, I have discovered that it took place in two very distinct periods of time."

To confirm this conclusion he placed two grams of powdered gypsum in a glass tube, which he heated gradually in a paraffin bath, recording by a thermometer the temperature every five minutes. Using the time as abcissa and the temperature as ordinates he constructed a curve. This curve did not rise regularly but contained two horizontal breaks in its regularity. The temperature after rising rapidly to 110° rose more slowly from 110° to

[1] Acad. des. Sci. Compt. Rend. 96, 1668. 1883.

120°, stood stationary a long time at 128° and then went on upward more rapidly between 130° and 140°; a second stop analogous to the first but less important took place at 163°. From the results of this experiment W. A. Davis[1] has plotted the following curve [fig. 6].

Le Chatelier then says, "These two halts in the rise of the thermometer were brought about by the absorption of heat which accompanied the elimination of the water. They indicate the existence of two hydrates having different temperatures of decomposition. To determine the composition of the intermediate hydrate, I heated 10 grams of gypsum at a temperature of 155° which from the above figures is intermediate between the decomposition temperatures of the two hydrates. The loss of weight was as follows:

TIME Hours	Minutes	GRAMS
....	15	.66
....	30	1.36
....	45	1.52
1		1.56
1	15	1.56

"The loss of weight at 155° tends then to a well defined limit of 1.56 grams which corresponds exactly to 1.5 molecules H_2O for 1 molecule of $CaSO_4$." This leaves us a material with a formula of $CaSO_4.\frac{1}{2}H_2O$ identical with "half hydrate" noted by Johnston[2] as found in the form of scale in a steam boiler heated to 121° C. and by Hoppe Seyler[3] as formed by gypsum in presence of water at 140–60° C.

The same sample was then heated to 200° C. with the following results:

TIME Hours	Minutes	LOSS OF WEIGHT Grams
....		1.56
....	15	1.78
....	30	1.98
....	45	1.98
1		2.08

This loss of 2.08 grams corresponds to two molecules of water to one of $CaSO_4$, that is, at 200° C. the dehydration is complete.

In summing up his results Le Chatelier says: "These experiments show that there exists at least one inferior hydrate of calcium sulfate having the formula $CaSO_4.\frac{1}{2}H_2O$ and that it

[1] Soc. Chem. Ind. Jour. 1907. 26:728.
[2] Phil. Mag. 1838.
[3] Pogg. Ann. 1866. 127:161.

contains 6.2 per cent water. The commercial plaster containing in the mean 7 per cent water is then almost exclusively made up of this hydrate."

In the past 10 years a number of chemists have taken up the question of the decomposition of gypsum, the formation of the half hydrate and the anhydrite and their mutual relationships. Among the number are Armstrong, Van't Hoff, Shenstone, Cundall, Cloez etc. [*see* Bibliography for references]. The most recent investigations are those by W. A. Davis[1] who, moved by the uncertainty and lack of uniformity in the results previously obtained, has carried out a series of careful experiments, which he presents along with a summary of the work performed by others. This very valuable contribution is presented herewith in abstract.

At the time Davis entered upon his investigations there were recognized, as derived from gypsum, the half hydrate, formed at 128° and decomposed at 163° [Le Chatelier]; the soluble anhydrite which according to Van't Hoff was formed directly by heating gypsum in a vacuum over concentrated sulfuric acid without the intermediate formation of the half hydrate, and natural anhydrite, which can be formed by strongly igniting the soluble anhydrite. The soluble anhydrite is very soluble in water and sets very rapidly to a hard mass.

Davis first heated a series of gypsum samples at temperatures between 98° and 130° C. and measured their successive loss in weight or loss in water and derived the following curves [fig. 7].

The influence of the state of division of the gypsum is clearly noticeable.

The striking feature in the curves, however, is that loss of water does not begin immediately after the material is heated. In one experiment a whole hour is shown to elapse before any water is given off. During this period the monoclinic gypsum is undergoing a crystallographic change to the orthorhombic system, or in other words $CaSO_4 . 2 H_2O$ is dimorphous, as are nearly all the hydrated sulfates of bivalent metals. Further proof of this is shown in the behavior of the half hydrate on setting. When the plaster first sets into a coherent mass, microscopic investigation has shown that all the crystals present have a straight extinction and are probably orthorhombic. Gypsum crystals subsequently appear because the orthorhombic form is labile at ordinary temperatures and, in from a few hours to a few days, changes to gypsum. This perhaps explains the fact that plaster when first set contracts (while the orthorhombic crystals are forming) and expands (at the change to monoclinic). At first sight the curves might suggest Van't Hoff's idea that no intermediate half hydrate is formed, but owing to the

[1] Soc. Chem. Ind. Jour. 1907. 26:727.

removal of water by the air the two dehydrations may go on side by side as follows:

$CaSO_4 . 2\ H_2O = CaSO_4 . \frac{1}{2}\ H_2O + 1\frac{1}{2}\ H_2O$

$CaSO_4 . \frac{1}{2}\ H_2O = CaSO_4 . + \frac{1}{2}\ H_2O$

This view is further substantiated by the heating of gypsum at 98° in an open crucible with the formation of half hydrate in nine hours and no further loss or change with eight hours heating.

Commercial plaster, Davis considers to be made up mainly of the half hydrate, not soluble anhydrite as held by Cloez, since the water vapor in the mass would immediately hydrate any anhydrite formed, or at least the moisture from the air would soon alter it to the half hydrate. Bottled samples of freshly made plaster almost

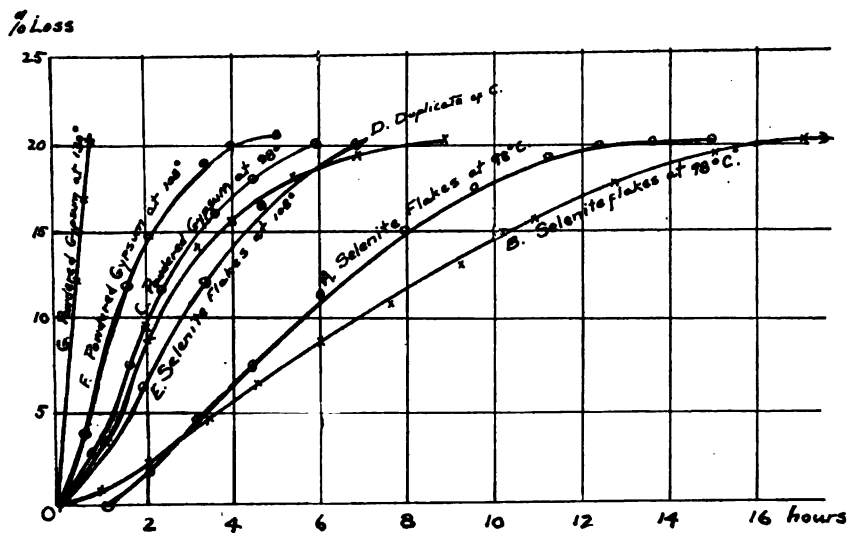


FIG. 7 Curves showing rates of dehydration of gypsum under different conditions. (After Davis)

always show 6 to 8 per cent water and are therefore the half hydrate.

In summing up then we may say that the change from gypsum to anhydrite is brought about as follows:

	LOSS IN WATER
1 $CaSO_4.2H_2O$ monoclinic to $CaSO_4.2H_2O$ orthorhombic........	none
2 $CaSO_4.2H_2O$ orthorhombic to $CaSO_4.\frac{1}{2}H_2O$ orthorhombic......	$1\frac{1}{2}$ mols
3 $CaSO_4.\frac{1}{2}H_2O$ to $CaSO_4$ (soluble) orthorhombic...............	$\frac{1}{2}$ mol
4 $CaSO_4$ (soluble) to $CaSO_4$ insoluble (natural anhydrite)......	none

Of these, the first two steps are carried out on calcining plaster and their reversal on the setting of plaster.

Davis classes freshly made plasters into four groups:

1 Those consisting mainly of the half hydrate, containing 6 to 8 per cent water.

2 Those containing soluble anhydrite and very hygroscopic, with less than 6 per cent H_2O.

3 Plasters containing more than 7.5 per cent H_2O and consisting of half hydrate mixed with some gypsum.

4 "Dead burnt" plasters containing less than 6 per cent water but not hygroscopic and setting slowly; these contain ordinary anhydrite.

Setting of plaster. The property of plaster, or the calcined gypsum, to set on mixing with water gives it its chief value. Gypsum calcined at temperatures varying perhaps from 100° C. to 500° C. and mixed with water will, after a period of from a few minutes to a day, take up water and become a hard mass.

The cause of setting has long been an unsettled and debatable theme, though the fundamental principle was laid down by Lavoisier in the investigations already noted. In addition to the experiments that have been described he carried on one more. Into a large vessel of water he threw some powdered plaster and allowed it to sink. He says, "In passing through the liquid, each molecule of plaster took back its water of crystallization and fell to the bottom of the dish under the form of small brilliant needles, visible only with a high power lens." Examined with a lens they proved to have the regular form of gypsum. He concluded that the setting with water "is nothing more than a simple crystallization"; gypsum, deprived of its water, reabsorbs it greedily and again becomes crystalline. Lavoisier thought that his investigations left no doubt as to the cause of the hardening of plaster, and that there remained "nothing to be desired in explanation of the problem." Though the change is caused primarily by a crystallization and the taking up of water, the chemical, crystallographic and physical changes in all their steps are far from clear; as stated by Mr Davis,[1] "the problem has proved to be one of extraordinary difficulty, and in spite of the investigations made by such well known chemists as Marignac, Le Chatelier and Van't Hoff, an amount of confusion exists with regard to the subject which is almost without parallel in inorganic chemistry."

Landrin[2] made an elaborate investigation into the setting of plaster and brought forward the theory that the plaster partially dis-

[1] *loc. cit.*
[2] Ann. de Chimie, 1874. p. 434.

solved in the water which became saturated with respect to it. The heat of the chemical reaction causes an evaporation of some of the water and a consequent crystallization of the saturated solution, the first crystal developed determining and hastening the crystallization of the whole mass. Le Chatelier later showed, however, that plaster would set in a vacuum so that evaporation was not the means of causing the crystallization.

Le Chatelier[1] in taking up the question utilized the observation of Marignac[2] that calcium sulfate in contact with water gives a supersaturated solution which allows the deposition of crystals of the hydrous calcium sulfate. With plaster cooked at 140° a solution is obtained containing 9 grams of $CaSO_4$ per liter, i. e. four times more than can normally exist in solution. Le Chatelier goes on to say that such supersaturated solutions, capable of uniting directly with water to form their hydrates are common, for example Na_2SO_4 Na_2CO_3 etc., all of which salts set when mixed with water. Finally he believes that the set is the result of two simultaneous phenomena: "On the one hand the masses of the plaster mixed with water dissolve themselves on hydrating and produce a supersaturated solution. On the other hand, this solution allows at the same time a deposition of crystals of hydrous calcium sulfate. They are added to little by little and bind themselves together."

G. P. Grimsley,[3] although agreeing with Le Chatelier and others that the set of gypsum is due to a formation of a network of crystals of gypsum crystallized from a saturated solution of the half hydrate, to account for the cause of the beginning of the crystallization advances this theory: "The effect of heat on gypsum in the burning of plaster as we have shown, is to remove a certain percentage of water, and to break up the small masses of the rock into finer and finer particles, microscopic and even ultramicroscopic in size. If the heat is not carried too far, certain particles through the mass may still possess their crystalline form and are true crystals though small. These minute crystals in the saturated solution would start the process of crystallization. . . If the plaster is underburned the gypsum is not reduced to the proper fineness and uniformity, and so would not permit the crystallization to go on in the way it would in a properly burned plaster. But of more importance, the hydrate represented by plaster of paris would not be formed. If the plaster is overburned, it will be so completely comminuted that no minute crystals will be left to start the crystal-

[1] Acad. de Sci. Compt. Rend. 96, 714. 1883.
[2] Ann. de Chimie de Physique Tome I, 279. 1874.
[3] Kansas Univ. Geol. Sur. 1899. 5:95.

lization. Where the plaster is slightly overburned, the crystals are extremely fine and crystallization goes on very slowly and imperfectly."

While the presence of any unburned gypsum may hasten or otherwise influence the setting of some plasters, it does not appear that the process is absolutely dependent upon that condition for its start. In the case of soluble anhydrite there is rapid setting on addition of water, which is hardly explainable by the view taken by Grimsley.

The approximate solution of the problem is undoubtedly to be found in the work of Davis. "It has always been assumed that the setting of plaster is due to the regeneration of gypsum by the action of water on the half hydrate. If, however, the setting of the half hydrate be carefully observed by means of the polarizing microscope, not a single gypsum crystal can at first be detected in the set mass; the cake of set material, during the first quarter of an hour after it has hardened to a coherent mass, which is only slightly indented by the finger nail, is made up of crystals showing a straight extinction only, and therefore probably orthorhombic. The first product of the setting of the half hydrate (or soluble anhydrite) is, indeed, the same orthorhombic dihydrate as is produced in the first stage of the dehydration of gypsum. Gypsum crystals subsequently make their appearance within the set mass, owing to the fact that the orthorhombic form of the dihydrate is labile at the ordinary temperature, and undergoes change more or less rapidly — during the course of several hours or several days, the time varying greatly — into the more stable form of gypsum. The series of changes

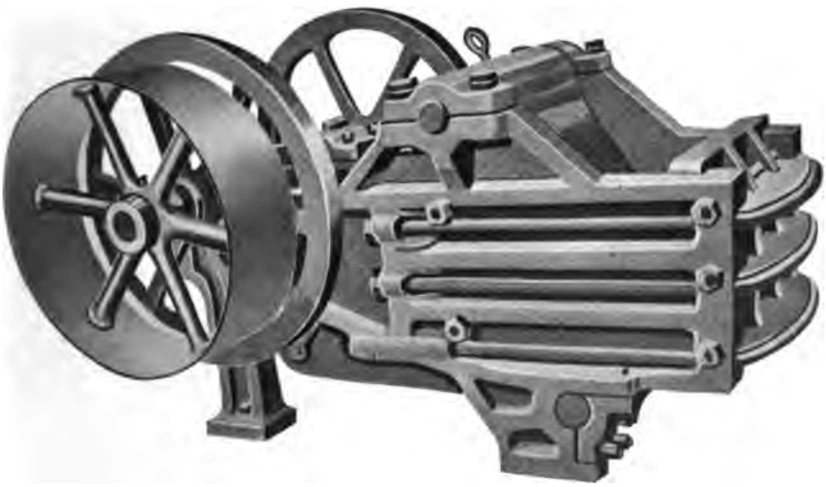
$$\underset{\text{Gypsum (monoclinic)}}{\alpha\ CaSO_4 . 2H_2O} \rightleftarrows \underset{\text{(orthorhombic)}}{\beta\ CaSO_4 . 2H_2O} \rightleftarrows \underset{\text{Half hydrate (orthorhombic)}}{CaSO_4 . \tfrac{1}{2} H_2O}$$

is, indeed, strictly reversible. Before gypsum can undergo dehydration to form the half hydrate, it passes into the orthorhombic form of the dihydrate, and the latter is also the first product of the hydration of the half hydrate."

Some recent experiments have been made by Leduc and Pellet[1] on the relation of calcining temperature to the setting of plaster. They calcined for an hour or more pure alabaster at various temperatures and mixed the plaster formed with 85 per cent water. The results of their experiments are as follows:

[1] Le Genie Civil. 1906. 49:253.

Plate 18



Jaw crusher

CALCINING TEMPERATURE	SET BEGINNING AFTER	SET COMPLETE AFTER
	Minutes	
120°C	8	16 minutes
250°C	4	6 minutes
450°	4	over 5½ hours
500°	....	24 hours
600°	....	24 hours
650°	....	no set
700°	....	no set
720°	....	no set
1185°	....	no set

This indicates that the most efficient temperature for calcining is at about 250° C. (482° F.).

TECHNOLOGY OF GYPSUM PLASTERS

Plaster of paris and wall plasters

The manufacture of the different calcined plasters is based on similar methods, though there is considerable variance in the details of practice and equipment of the plants. In every case the crude gypsum from the mines or quarries must undergo the two operations of crushing and calcination.

The plasters made in New York and also practically all those manufactured in this country belong to the half hydrate class, i. e. their basis is plaster of paris. Their varied qualities depend mainly upon the proportion of impurities present in the original rock and upon the addition of artificial materials to hasten or retard the setting process. The anhydrous plasters which include the so called "cements" and the German flooring plasters form a distinct group that can best be considered under a separate head.

Crushing. The crushing of the material may be performed either before or after calcination. The general practice in this country is to make a partial reduction at least before burning, though abroad the crude rock is often calcined in arched kilns in a manner similar to the burning of limestone. With the kettle process, which is widely used in American plants, the rock is reduced to a fine powder before calcination. The introduction of rotary cylinders for calcining among the newer plants involves a change of the crushing process whereby the rock is subjected to

a preliminary reduction to uniform size and after calcination is given a second treatment for pulverization.

The first step in reduction is performed in a coarse crusher, by which the rock of size convenient for handling is broken to lumps of about 1-inch diameter. The crushers commonly used are of the jaw or gyratory types, the preference in New York plants being given to the former. One form of jaw crusher or "nipper" specially devised for gypsum plants is shown in plate 18. The movable jaw, as well as the end plate, sometimes has a corrugated surface which prevents the soft material from clogging the outlet. The machine shown in the illustration weighs 13,000 pounds and will crush each hour from 15 to 30 tons of rock.

From the coarse crusher the gypsum passes into the "cracker." This machine works like a coffee mill, having a corrugated shell of inverted conical shape within which revolves a corrugated spindle [pl. 19]. The machines have a capacity of from 3 to 12 tons an hour and crush to about pea size.

After this treatment, the gypsum is ready for charging into rotary cylinders if these are used for calcination. For the kettle process, however, it is next run through a fine grinder of which there are several forms well adapted for the purpose. In the mills first erected the grinding was universally done by buhrstones, and this practice continues to be quite common, though it has been superseded in most of the modern plants by more improved methods. The stones are set the same as in flour mills and may be of French or domestic make. The small expense of such an oufit is its chief recommendation and is offset by the necessity of redressing the stones from time to time, an operation that requires a high degree of skill.

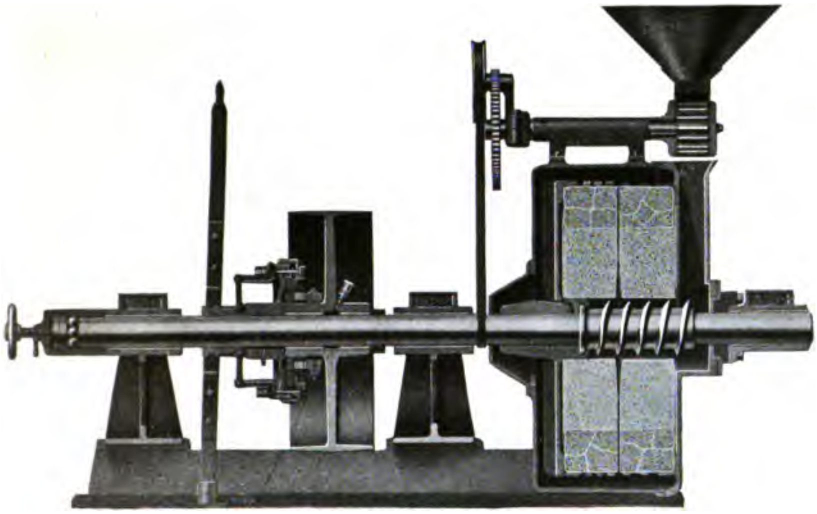
An improvement on the horizontal millstones for grinding gypsum is the use of a vertical mill which can be run at a higher speed. This type is common abroad. The Sturtevant Mill Co. of Boston manufactures a vertical mill of special construction that has been installed in several plants. The stones are built up of emery blocks set in a metal shell around a central disk of buhrstone. The emery blocks are held secure by metal filled in while molten. A 36-inch Sturtevant mill is shown in section in plate 20. The mill is supplied with an automatic feeder from which the gypsum is carried by a worm conveyor and forced between the stones.

Another machine in use for pulverizing gypsum is illustrated in plate 21. It is made by the Williams Patent Crusher & Pulver-

Plate 19

Type of cracker used in crushing gypsum

Plate 20



Section of Sturtevant mill

Plate 21

The Williams pulverizer

izer Co. of St Louis. The reduction is accomplished by means of hammers carried on a rapidly revolving horizontal axis and working against a corrugated breaker plate. The machine is said to take rock that will pass through a 2-inch ring and crush from 12 to 15 tons an hour through a 30-mesh screen.

The Stedman disintegrator, which is characterized by a series of concentric cages with steel crossbars, the adjacent cages revolving in opposite directions and crushing the rock by impact, is employed in some of the western plants. The roller mills in use for grinding flour is also said to be serviceable for gypsum.

There seems to be no standard of fineness for plasters, such as obtains in cement manufacture. The size of the particles, however, is not without influence upon the setting qualities, though within the moderate limits of variation in ordinary practice the degree of fineness does not appear to be very important. A series of sieve tests on marketable plaster from the middle western districts has been published by the Iowa Geological Survey,[1] the results of which show that an average of 70 per cent of the ground plaster will pass through a sieve with 74 meshes to the linear inch, about 60 per cent through a 100-mesh sieve and 44 per cent through a 200-mesh sieve.

Calcination. The chemical features of the calcination process are described elsewhere in detail. Though the process is simple in theory, as well as in its mechanical requirements, it demands a degree of experience and skill to insure a uniformly satisfactory product.

The common kettle method of calcination as used in this country is an adaptation of the earlier practice by which plaster of paris was made on a small scale in a cauldron kettle over an open fire. The modern kettles are cylinders of boiler steel, nearly square in vertical section, set upright on a brick foundation. Their diameters range from about 8 to 10 feet. The sides are constructed of sheet iron 3/8 to 5/8 inch thick, while the bottoms which must withstand extremes of temperature are usually cast from the best grade of scrap iron, and their thickness varies from 3/4 inch at the edges to 4 inches in the centers. The bottoms are arched upward rising about a foot at the crown. Some kettles are made with sectional bottoms, so that in the case of breakage it is only necessary to replace the broken part instead of installing a new bottom. The cover is of sheet iron and has a trap through which the charge is introduced.

[1] An. Rep't 12. 1902. p. 162.

The kettle is inclosed nearly to the top by a brick wall with an open space between for the circulation of heat. The fire chamber below is a little narrower than the kettle and rises from 4 to 7 feet above the grate bars. The heated gases pass through ports into the open space at the base, then into flues which are placed horizontally in the kettle itself and out through a stack. The flues are built in sets of two or four. In a kettle of two flues they are placed parallel about 8 inches above the crown. The arrangement in a kettle of four flues is shown in plate 22 taken from a photograph furnished by Butterworth & Lowe, Grand Rapids, Mich. The kettle illustrated measures 10 feet, 4 inches across by 8 feet, 5 inches high and will calcine 10 tons of ground gypsum into plaster of paris at a single charge. The weight of the metal is about 10 tons.

The kettles are generally installed in line and worked in pairs with a feeding chute and a pit for the calcined product between each pair. In burning it is necessary to keep the gypsum in constant agitation, for otherwise the hot mass would soon destroy the kettle bottom. The agitation is accomplished by means of a vertical shaft to which paddles are attached and which is turned at the rate of 15 revolutions a minute by means of a crown wheel connecting with a pinion on the mill shafting. From 10 to 25 horsepower is required to maintain the agitation.

The arrangement of an installation in a kettle plant is shown in figure 8, which is reproduced from a drawing furnished by Butterworth & Lowe.

In operation, the kettle is charged with ground gypsum through the trap in the cover and is filled in about an hour. Heat is gradually applied during the process, and when the temperature reaches 220° or a little above, the mass begins to boil vigorously from the escape of the mechanically held moisture. After this is evaporated there is a noticeable settling, and the steam almost ceases for a time. With increasing heat a second ebullition begins between 280° and 290° F., causing the mass to rise to the top of the kettle. The steam now is due to water of crystallization which continues to come off as the heat is raised. When the boiling begins to slacken, the mass settles again and is ready for removal into the fire brick bins for cooling. The finishing temperature ranges between 350° and 400°, as there is no fixed point which marks the completion of the process. The experienced calciner relies chiefly upon the physical appearance of the plaster, the amount of steam given off and the creaking of the machinery during the settling as guides in the

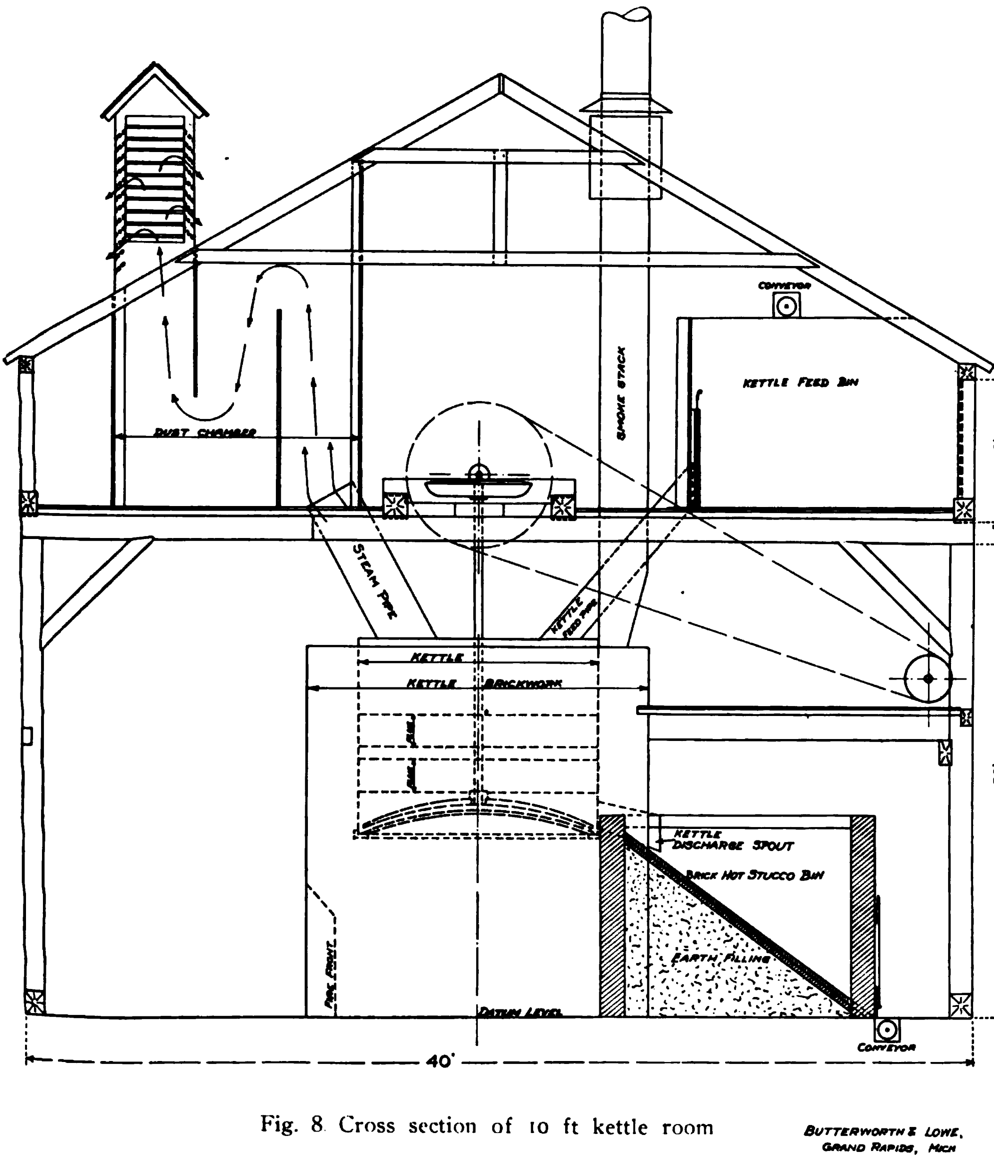


Fig. 8. Cross section of 10 ft kettle room

BUTTERWORTH & LOWE, GRAND RAPIDS, MICH

operation, though thermometers are used in some plants as a further check. The wide range of temperatures at which the burning is completed may be ascribed largely to the variation in the purity of the gypsum. According to Paul Wilkinson[1] the temperatures used in the manufacture of plaster of paris from the Kansas rock, which averages very high in gypsum, do not exceed 340° F., while they run about 396° F. as a maximum in the calcination of the impure earthy gypsum.

If the calcination is finished at too low a temperature the change to half hydrate will be incomplete; the plaster in that case will be deficient in strength. On the other hand, if the temperature is carried too high, there is danger of converting a part of the whole of the charge into anhydrite. Soluble anhydrite results when the overburning is continued for a short time only and insoluble anhydrite when it is of longer duration and at still higher temperature. The presence of soluble anhydrite in plaster freshly burned is perhaps not uncommon, though the main ingredient is, of course, the half hydrate. According to Davis any soluble anhydrite in the product will take up moisture from the air to form half hydrate, so that its presence in small amount may have no detrimental effect.

The time required for the calcination of a charge ordinarily is from two and one quarter to three hours, depending on individual practice. The fuel consumption with bituminous coal averages from 200 to 300 pounds for each ton of plaster. After cooling in the pits the product is elevated to a revolving screen, which removes any coarse material for regrinding, and is then transferred to the storage bins.

The kettle process has been criticized frequently as uneconomical, and this is undoubtedly a serious drawback. Its simplicity and the fact that plaster makers have grown accustomed to visual methods of controlling the burning operation seem to be the main reasons for its continued favor. As compared with the rotary kiln the kettle consumes for each ton of plaster made, more fuel in calcination and more power in agitating the charge, while it is less efficient by reason of its interrupted operation.

The Cummer rotary kiln is the only continuous calciner in use in this country. It is made by F. D. Cummer & Son Co. of Cleveland. The apparatus as installed for operation is shown in plate 23.

The gypsum rock is not pulverized as in the kettle process but is crushed to pass through a ¾-inch ring and delivered to the storage bin over the feed spout of the kiln. This consists of a steel

[1] Am. Inst. Min. Eng. 1897. 27:516.

cylinder set on a slight incline and turned slowly on roller bearings by means of a large spur wheel at the upper end. The rock enters the cylinder at the same end and gradually works its way down as the cylinder revolves, being lifted and dropped by blades attached to the sides. The hot gases from the furnace are forced by a fan into the brick chamber surrounding the cylinder where they are mixed with sufficient air, admitted through the registers at the base, to give the desired temperature. From the co-mingling chamber the air and furnace gases are drawn by a fan through hoods into the interior of the cylinder which they traverse in a direction opposite to that taken by the material. The temperature of the interior is maintained between 400° and 600° F., according to the character of the rock and the desired product. As the rock remains in the cylinder only 10 minutes, there is little danger of overheating incident to the kettle method. A thermometer is placed in the discharge spout where the operator can watch it and regulate the flow of gases so as to give a uniformly heated product.

An indispensable feature of the Cummer process is the calcining bins into which the steaming material from the kiln is removed. Four bins are required for each cylinder. They are made of brick and lined with paving brick which have little absorbing power. The material remains in the bin for about 36 hours, during which time the free moisture not driven off in the cylinder is removed as well as a further part of the water of crystallization. While the calcination is going on in the bin, outside air is excluded, thus allowing the heat of the material to equalize itself throughout the mass. Small variations in temperature during the day's run of the cylinder have little or no influence on the character of the product so long as the average remains fairly constant. With the use of four bins the process is absolutely continuous; while one is being filled, calcination is going on in the second and third, while the fourth is being emptied.

The arrangement of a mill in which the Cummer process is used is shown in figure 9. The kiln is installed in the plant of the Lycoming Calcining Co. at Garbutt, which has a capacity of 50 tons of plaster in 11 hours. The fuel is soft coal. According to the manufacturers' circular the consumption of fuel, when a good grade of coal is used, averages about 70 pounds for each ton of calcined material, exclusive of that employed for driving the plant, which is a relatively small item.

Another continuous process is described by F. A. Wilder[1] as in

[1] Iowa Geol. Sur. 1902. 12:213.

Plate 22

Four-flue kettle for calcination of gypsum

use at Mannheim, Germany. The calciner consists of a fire box and automatic stoker opening into the chamber that contains the rotating cylinder. Above the cylinder and connected to it by a pipe is a chamber through which a spiral conveyor passes. The gypsum ground to a size not larger than a hickory nut is charged into the forewarmer, is conveyed by the spiral to the other end and dis-

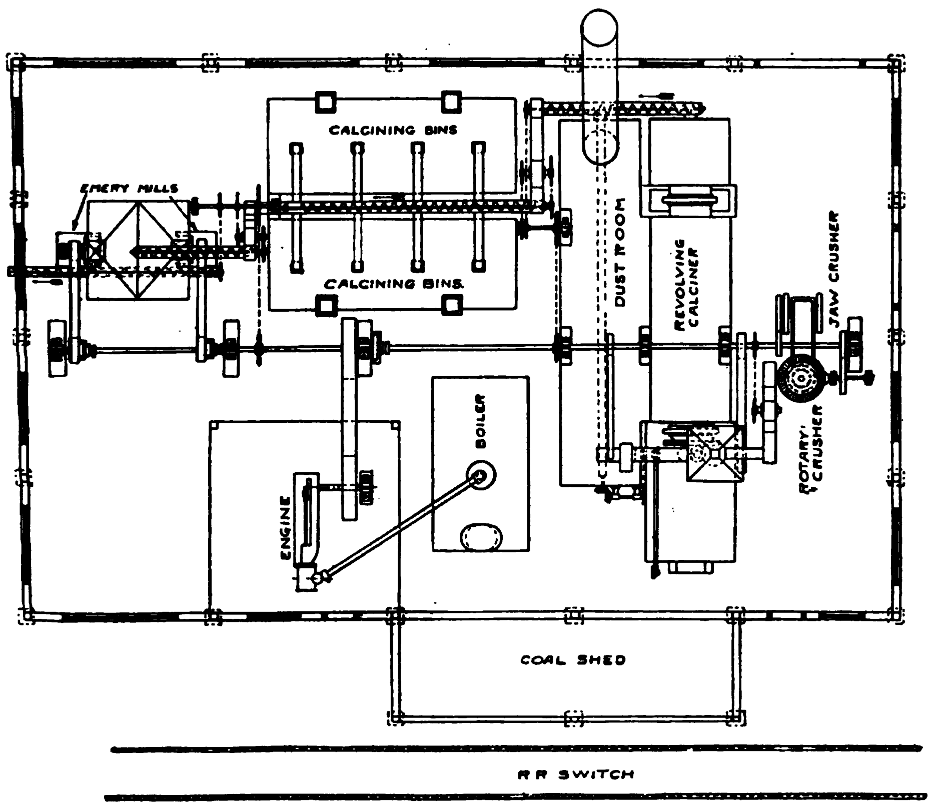


FIG. 9 Arrangement of installation for Cummer process

charged into the rotary cylinder. A fan forces the hot air and gases from the fire box into the cylinder and this calcines the gypsum and forces it toward the discharge end of the cylinder. The material is agitated by a continual lifting and dropping brought about by a series of shelves or buckets on the sides of the revolving cylinder. The larger lumps which would require a longer period of heating for calcination, owing to their weight, are moved most slowly toward the discharge point, and thus receive the most heat,

while the fine powder which if allowed to remain long in contact with the heat would become dead-burned, passes quickly to the rear end of the cylinder under the blast of air. The gases and hot air pass out of the cylinder and into the forewarmer where whatever heat remains in them is utilized in heating the crude gypsum on its way to the cylinder. The gases and air, then with a temperature of but 80° F., pass into collecting chambers to recover any dust of plaster in them, and thence out through the stack.

In Europe gypsum is commonly burned in lump form in arched kilns, which are built of masonry and somewhat resemble the ordinary brick kiln of this country.[1] The heat from the central fire pit is conducted through radiating channels, which are constructed of the larger gypsum blocks, and then finds its way upward in the spaces between the lumps to issue finally through flues in the roof.

Plaster of paris used in porcelain and china ware manufacture requires careful preparation, as it must form a light, porous mass when set. This grade is made mostly in France and Germany. The calcination is often carried out in brick ovens, the gypsum being stirred frequently during the process. An improved type of oven that is now employed in Germany for making porcelain plaster takes the form of a long room constructed of brick into which the gypsum is carried on cars.[2] These have racks holding five or more shelves which are loaded with rock that has been previously crushed to 1-inch size or smaller. The room is heated by a furnace below, the gases passing through flues in the walls and not coming into contact with the gypsum. The temperature is maintained uniformly at 140° C. (284° F.). Three charges are burned in a week, and the output of each is about 8 or 9 tons of calcined plaster.

Resultant product. The product resulting from the operations just described is a finely divided calcined plaster. If a pure gypsum has been used it will consist of calcium sulphate plus a small residue of water, the amount depending upon the degree to which the calcination is carried. The ideal composition of plaster of paris is represented by the formula $CaSO_4 \cdot \frac{1}{2} H_2O$ which calls for 93.8 per cent of calcium sulphate and 6.2 per cent of water. These percentages are approached in high grade plaster of paris, which finds special uses, but most wall plasters contain a considerable proportion of impurities due to the admixture of clay, lime, magnesia etc. with the gypsum.

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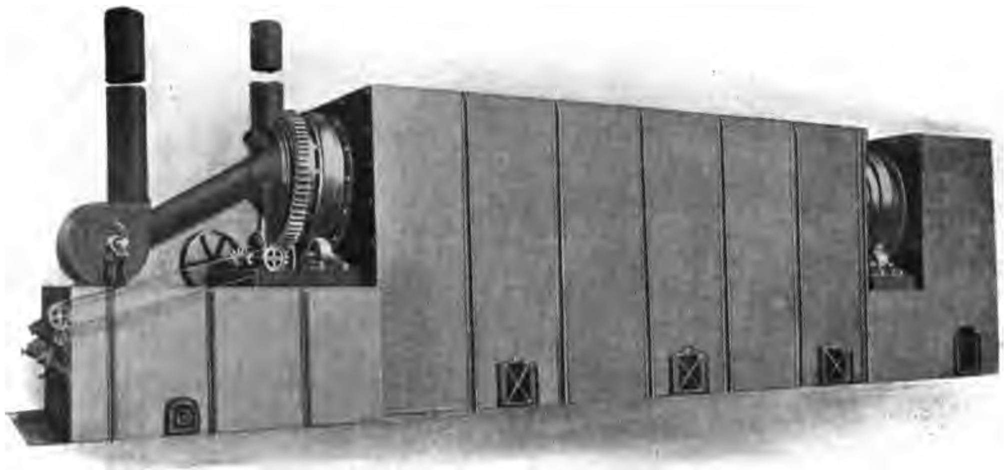
[1] Grimsley, G. P. Technology of Gypsum. Mineral Industry. 1899. 7:390.

[2] Wilder, F. A. The Gypsum Industry of Germany. Iowa Geol. Sur. An. Rep't 12. 1902. p. 217.

Plate 23



Cummer rotary calciner

The composition of the plaster, other things being equal, is an index of its setting properties. A pure plaster of paris of normal fineness when mixed with water will harden in about six minutes. This is known as the initial set.[1] Impure plasters, on the other hand, may require an hour or more to harden.

Addition of retarders. Plasters intended for wall and other structural purposes must be slow setting to avoid difficulty in manipulation. If this is not a natural property, which may be found in the impure sorts, it is necessary to induce slow setting by the addition of some foreign material. As a matter of fact practically all wall plasters, however impure, require treatment with a "retarder" by which the time of setting is prolonged to from two to four or five hours, according to need.

The retarders employed by manufacturers of wall plasters include such materials as glue, glycerine, chemically prepared hair, slaked lime, sawdust, and the tankage from packing houses. Most manufacturers have a preference for some particular material, the nature of which, as well as the proportions used, is generally carefully guarded. There are also several patented preparations on the market. The effect of the retarder is probably to decrease the solubility of the plaster and thus to extend the period of hydration and recrystallization.

The retarder is added to the cool ground plaster in amount varying from 2 to 15 pounds a ton and is thoroughly incorporated by the use of a mixing machine.

Wall plasters also contain some fiber — hair, wood or asbestos — which is added before mixing. From 1 to 3 pounds of hair to a ton of plaster is the general proportion. The hair must be previously teased out by a picker. The wood fiber is made from a soft wood like poplar, willow or basswood. The wood, cut into 20-inch lengths, is run between two revolving toothed cylinders which rapidly shred it. The mixing of the various ingredients is usually carried on in a mixing machine known as the Broughton mixer [pl. 24].

Anhydrous plasters

This class of plasters has as a basis the dehydrated product which results from calcination of gypsum at a higher temperature than is used in plaster of paris manufacture. Such plasters are

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[1] The set of plaster is determined in the same way as in the case of cements. The apparatus commonly used is the Gilmore needle. A sample pat having been made from the plaster, a needle of ½ inch cross section loaded with a 4-ounce weight is placed on it. The initial set is completed as soon as the needle fails to make an impression.

characterized by slow setting when mixed with water and by a hardness superior to that of the half hydrate class. They are used more specially as material for floors and for hard finishing of walls, and corresponding to these uses two general varieties may be recognized — *Estrichgips* or flooring plaster which was first introduced in Germany, and the so called cements, of which Keene's cement is a common example.

The manufacture of flooring plaster is still centered largely in Germany. Its technology has been described briefly by Wilder.[1] The nature of the material is still not well understood, though an investigation by Van't Hoff and G. Just[2] has thrown some light on the subject.

According to Wilder, Estrich gypsum is prepared by calcination of rock gypsum at a temperature of about 500° C. The rock is not crushed, but taken directly from the quarry to the kiln. The kiln resembles that used in lime burning. The gypsum blocks are thrown in at the top and pass over an inclined grate which lies over a fireplace. They slowly work their way over the grate, through a constricted space, and finally, when calcined, fall into a cooling chamber. No attempt is made toward a close control of temperature.

Estrich gypsum has come into general use in Germany as a flooring material for office buildings, factories etc., where it takes the place of portland cement. It admits of coloring and polishing, so as to yield a good imitation of marble or other attractive stone.

Hard finish plasters or gypsum cements are made from anhydrous plaster by treatment with some chemical. The best known representative of these plasters is Keene's cement, which was first manufactured in England. The burning process is performed in a vertical kiln, somewhat similar to that just described, where the rock reaches a red heat. The dehydrated material is then treated with a 10 per cent alum solution, after which it is again burned at high temperature and ground for use. The action of the alum is perhaps to assist the solution of the dead-burned gypsum. The plaster sets slowly and when quite stiff can be softened again with water, without impairing its hardening power. The high temperature at which it is burned tends to oxidize any iron present so that a perfectly white product can be made only from rock gypsum that is practically free from such impurity.

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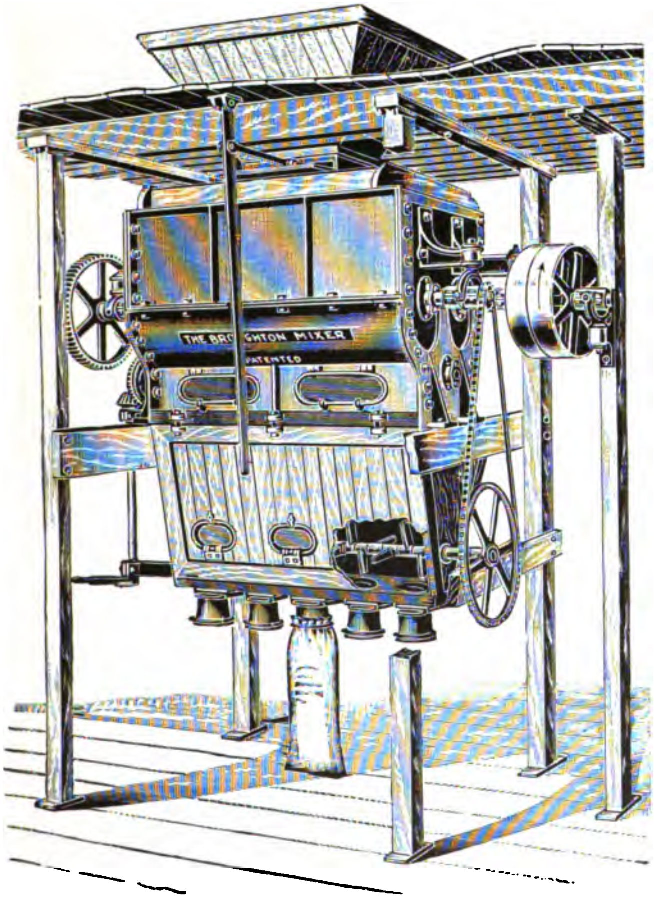
[1] *Op. cit.* p. 219.

[2] Kgl. Preuss. Akad. Wissensch. 1903. 1:249. A translation of this paper appears in E. C. Eckel's *Cements, Limes and Plasters.*

Plate 24



The Broughton mixer

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Appendix 3

Entomology

Museum Bulletins 136, 141

136 Control of Flies and Other Household Insects

141 25th Report of the State Entomologist 1909

Education Department Bulletin

Published fortnightly by the University of the State of New York

Entered as second-class matter June 24, 1908, at the Post Office at Albany, N. Y., under the act of July 16, 1894

No. 465 ALBANY, N. Y. FEBRUARY 15, 1910

New York State Museum

JOHN M. CLARKE, Director
EPHRAIM PORTER FELT, State Entomologist

Museum Bulletin 136

CONTROL OF FLIES

AND

OTHER HOUSEHOLD INSECTS

BY

EPHRAIM PORTER FELT Sc.D.

New York State Education Department
Science Division, January 25, 1910

Hon. Andrew S. Draper LL.D.
Commissioner of Education

SIR: In April of last year I communicated to you a bulletin by the State Entomologist entitled the *Control of Household Insects.* This publication, which was issued to a considerable edition, has been entirely exhausted and the demand continues. To meet this outstanding demand for knowledge in regard to household insect pests, I transmit to you herewith the manuscript for a new edition of this work, enlarged in its scope, and recommend its publication as a bulletin of the State Museum.

Very respectfully
JOHN M. CLARKE
Director

State of New York
Education Department
COMMISSIONER'S ROOM

Approved for publication this 26th day of January 1910

A. S. Draper

Commissioner of Education

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CONTROL OF FLIES

AND

OTHER HOUSEHOLD INSECTS

BY

EPHRAIM PORTER FELT Sc.D.

INTRODUCTION

The discovery that the common house fly may, under certain conditions, play a most important part in the dissemination of tuberculosis, typhoid fever and other diseases of the alimentary tract, has effected in recent years a marked change in the attitude of the public toward this very prevalent nuisance. This statement should not be construed as meaning that the common house fly is necessarily the principal agent in disseminating the above mentioned diseases, though it would not be surprising, were we fully acquainted with the facts, to find that this familiar and almost universally tolerated species has been much more active in this respect than hitherto suspected. An insect, breeding as does the house fly upon organic matter, and feeding indiscriminately upon material which may be literally swarming with deadly germs, and other substances likely to be used as food, can hardly be regarded as other than a menace to human life and happiness.

Recent discoveries respecting the part played by insects in the dissemination of malaria, yellow fever and typhoid fever, read like a romance. Mosquitos as distributing agents of malaria have

been suspected for many years. An active impetus was given to this suspicion through the discovery by Ross that certain Indian mosquitos harbored a malarial parasite affecting birds. It was only a step from this to human malaria. The mosquito-malarial theory took such firm hold that in 1900 Drs Low and Sambon spent the summer on the fever-ridden Roman campagna, relying entirely for protection from malaria upon flimsy mosquito netting. Their field test was further confirmed by the shipment of malarial-infected mosquitos to London, where they were allowed to bite Dr Patrick Manson's son, who in due time came down with the disease though residing in a nonmalarious section.

The deadly, justly dreaded "yellow jack" has likewise been traced to its lair through the heroism of a few devoted scientists. Volunteers lived in a fever-stricken locality with no protection from infection other than the frail mosquito bar. They even slept in beds soiled by fever patients for the sake of demonstrating beyond question that the disease was not infectious. Drs Carroll and Lazear went further and allowed themselves to be bitten by infected mosquitos. Both contracted the disease, the latter losing his life on the altar of scientific investigation. This was true heroism. All honor to these martyrs. Theirs was not a useless sacrifice. Before their time, a yellow fever outbreak meant the loss of hundreds or thousands of lives, simply because there was no known adequate method of preventing the disease. Prolonged, arbitrary and wasteful quarantines were maintained. Thousands fled from infected districts. The horrors of the shotgun quarantine prevailed. The control of the yellow fever epidemic of 1905 in New Orleans is a most striking testimony to the value of the recent discoveries regarding this disease. This outbreak was handled as a mosquito-borne infection and for the first time the disease was stamped out before cold weather and with comparatively little loss in either life or property.

DISEASE CARRIERS

Typhoid or house fly[1]

The typhoid or house fly is such an extremely common species that a detailed description is almost unnecessary. Dr Howard's investigations show that fully 98% of the flies in houses are ordinary house flies. A few others are associated with this very

[1] Musca domestica Linn.

prevalent nuisance. The stable fly[1] may be rather abundant about houses in the fall and is responsible for the persistent belief that under certain conditions the house fly bites. Invariably the offender is this inhabitant of the barn, a form which presents an extremely close general resemblance to the fly and is perhaps best recognized by its bite. Another fly liable to be abundant about houses in the fall is known as the cluster fly[2] a species somewhat larger than the house fly and easily recognized by the yellowish hairs upon the thorax. The small, yel-

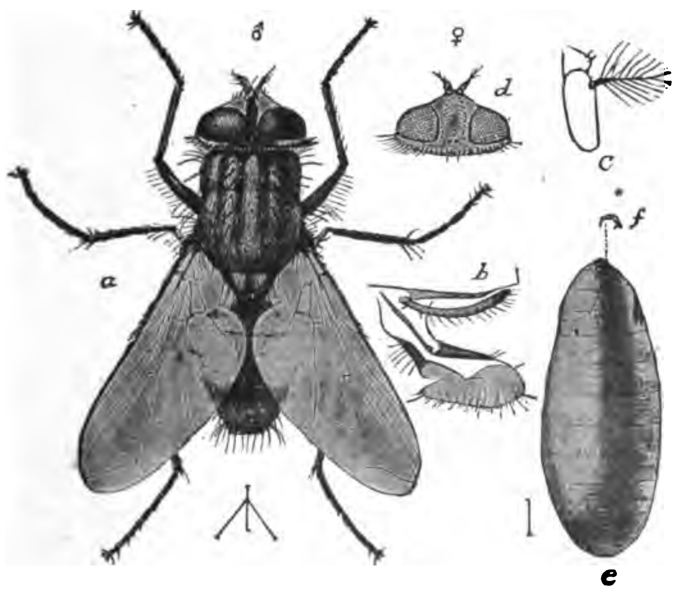

Fig. 1 Typhoid or house fly ; *a*, male, seen from above ; *b*, proboscis and palpus from the side; *c*, tip of the antenna; *d*, head of female ; *e*, puparium ; *f*, the anterior breathing pore or spiracle, all enlarged. (After Howard & Marlatt, U. S. Dep't Agric. Div. Ent Bul. 4 n. s. 1896)

lowish fruit fly,[3] only about ⅛ of an inch long, is sometimes rather abundant in houses and is invariably found in association with overripe or decaying fruit. These species, though annoying and under certain conditions dangerous, are insignificant offenders compared with the common house fly.

Description. The egg of the house fly is a slender, whitish object grooved on one side somewhat like a grain of wheat and only 1/20 of an inch long.

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[1] Stomoxys calcitrans Linn.
[2] Pollenia rudis Fabr.
[3] Drosophila ampelophila Loew.

The maggot, or more properly larva, is invariably whitish at first, very small and when full grown only about 1/3 of an inch long. The body tapers from the large, nearly truncate posterior extremity to the slender head.

The resting or transforming stage known as the puparium, is oval, brownish, ringed and scarcely 1/4 of an inch long.

The parent insect or adult fly is about 1/4 of an inch long, rather slender, dull grayish and therefore easily distinguished from the stouter, metallic blue or green bottle flies occasionally seen in houses and especially about meats.

A disease carrier.[1] Typhoid fever is one of the most serious ailments to which man is subject. There are about 500,000 cases of this disease annually in America, about 50,000 proving fatal. 60% of the deaths in the Franco-Prussian War and 30% of the deaths in the Boer War were caused by this disease. Dr M. A. Veeder of Lyons in 1898, was very strongly of the opinion that the house fly was largely responsible for the dissemination of this disease in camps. Dr Walter Reed writing of an outbreak near Porto Principe in the annual report of the War Department states that the outbreak " was clearly not due to water infection but was transferred from the infected stools of patients to the food by means of flies, the conditions being especially favorable for this manner of dissemination." Dr Vaughan, a member of the army typhoid commission, writes as follows respecting conditions in the Spanish-American War:

27 Flies undoubtedly served as carriers of the infection.

My reasons for believing that flies were active in the dissemination of typhoid may be stated as follows:

a Flies swarmed over infected fecal matter in the pits and then visited and fed upon the food prepared for the soldiers at the mess tents. In some instances where lime had recently been sprinkled over the contents of the pits, flies with their feet whitened with lime were seen walking over the food.

b Officers whose mess tents were protected by means of screens suffered proportionately less from typhoid fever than did those whose tents were not so protected.

c Typhoid fever gradually disappeared in the fall of 1898, with the approach of cold weather, and the consequent disabling of the fly.

It is possible for the fly to carry the typhoid bacillus in two ways. In the first place fecal matter containing the typhoid germ may adhere to the fly and be mechanically transported. In the

[1] For a bibliography of flies and disease, see N. Y. State Mus. Bul. 134, 1909. p. 32-40.

second place, it is possible that the typhoid bacillus may be carried in the digestive organs of the fly and may be deposited with its excrement.

Dr Alice Hamilton in 1903, studying the part played by the house fly in a recent epidemic of typhoid fever in Chicago which could not be explained wholly by the water supply nor on the grounds of poverty or ignorance of the inhabitants, captured flies in undrained privies, on the fences of yards, on the walls of two houses and in the room of a typhoid patient and used them to inoculate 18 tubes, from five of which the typhoid bacillus was isolated. She further found that many discharges from typhoid patients were left exposed in privies or yards, and concluded that flies might be an important adjunct in the dissemination of this infection. More recently, Dr Daniel D. Jackson investigating the pollution of New York harbor in 1907 to 1909, found that by far the greater number of cases occurred within a few blocks of the water front, the outbreak being most severe in the immediate vicinity of sewer outlets. He gives a series of charts showing an almost exact coincidence between the abundance of house flies and the occurrence of typhoid fever, when the dates are set back two months to correspond to the time at which the disease was contracted. He is of the opinion that most of the typhoid cases in New York originate in local infections carried by flies. The bacilli of typhoid fever were found by Ficker in the dejecta of house flies 23 days after feeding, while Hamer records the presence of this bacillus in flies during a period of two weeks. It has recently been found that flies produced from maggots living or developing in infected material are capable of conveying disease even when not exposed to subsequent infection. Most significant of all, it should be noted that competent physicians in position to make extended observations upon this disease and the methods by which it may be disseminated, are of the opinion that under certain conditions at least, the fly is a very important factor. Epidemics spread by flies, according to Dr Veeder, tend to follow the direction of prevailing warm winds. He considers flies the chief medium of conveyance in villages and camps where shallow, open closets are used, thus affording the insects free access to infected material, and where it is possible to eliminate water and milk as the sources of infection. Drs Sedgwick and Winslow, writing in 1903 state that "the three great means for the transmission of typhoid fever are fingers, food and flies," the authors holding the last to be the most important.

Typhoid fever, while a most dangerous infection, is not the only disease which may be conveyed by flies. Certain forms of diarrhoea and enteritis are undoubtedly due to specific germs, and there is no reason why the bacilli causing these infections may not be carried as easily and in the same way as those responsible for typhoid fever. The monthly bulletin of the New York State Department of Health for October 1908, states that during 1907 there were in New York State 37,370 deaths of infants under 2 years of age, 9213 being due to diarrhoea and enteritis. Careful investigators, it is stated, have placed the proportion of deaths between bottle-fed and breast-fed babies as 25 to 1. Physicians recognize the necessity of providing pure milk for young children, and in most instances it is comparatively easy to see how flies might be responsible for the major portion of the infections, since they usually occur in numbers about stables, in the vicinity of milk houses, in the neighborhood of milk stations, on milk wagons and, in fact, are found in greater or less numbers wherever milk is stored, excepting in refrigerators and similar places. Martin states that each succeeding year confirms his observation of 1898 to the effect that the annual epidemic of diarrhoea and typhoid is connected with the appearance of the common house fly, while Nash, in the *Lancet,* records no mortality from diarrhoea among infants at Southend during July and August 1902, this immunity being accompanied by the almost complete absence of the house fly. This insect was abundant in that locality in September and coincidently epidemic diarrhoea developed. Sandilands, in the *Journal of Hygiene,* states that the great majority of cases of diarrhoea are due to the consumption of infected food, and suggests that the seasonal incidence of diarrhoea coincides with and results from the seasonal prevalence of flies. Dr Jackson of New York records several epidemics of a malignant type of dysentery radiating from a single point and disappearing entirely when proper disinfection of closets was enforced.

The evil possibilities of the fly are by no means exhausted in the above recital. It is well known that flies feed upon sputum. Experiments by Lord recorded in the *Boston Medical and Surgical Journal* show that flies may ingest tubercular sputum and excrete tubercular bacilli, the virulence of which may last for at least 15 days. He considers the danger of human infection from this source to lie in the ingestion of fly specks on food, and suggests

that during the fly season great attention should be paid to the screening of rooms and hospital wards containing patients with tuberculosis and laboratories where tubercular material is examined.

The evidence showing that flies may play an important part in the diffusion of cholera is, according to Dr Nuttall, absolutely convincing. He cites experiments showing that cholera bacilli may be found on flies in large numbers, while they may occur in the dejecta within 17 hours after feeding and as late as four days. Infected flies have been given access to milk and cholera cultures made therefrom.

Dr Nuttall considers that the evidence previously submitted proves that the house fly may carry about and deposit anthrax bacilli, though there may be a question as to how generally flies are responsible for the dissemination of this disease. Parke admits the possibilities of flies distributing, in addition to diseases mentioned above, plague, trachoma, septicemia, erysipelas and leprosy. Furthermore, there are those who would hold flies responsible for the more frequent new cases which occur in the zone immediately surrounding the smallpox hospital and which may be due either to the wafting out of infected particles or their carriage by flies. The latter is considered the more probable. Yaws or framboesia is a tropical infection carried by this household pest. Howe, according to the statement of Dr Howard, has demonstrated that the purulent conjunctivitis of the Egyptians is spread by the house fly. The experiments of Grassi show that the eggs of Taenia, Trichocephalus and Oxyuris pass uninjured through the alimentary tract of flies.

Methods of carrying diseases. The most common and dangerous infections conveyed by the house fly are typhoid fever, other intestinal disorders, including those affecting young children, and tuberculosis. Typhoid germs may be discharged from the human system several weeks before diagnosis is possible, continue in numbers 6 to 8 weeks after apparent recovery, and in exceptional cases may persist during a period of several years. There are authentic records of a patient distributing these germs for 17 years and being the incipient cause of 13 cases during 14 years of that period. Even the urine of patients may contain active typhoid bacilli. Furthermore, Dr M. A. Veeder of Lyons cites a case where typhoid fever was perpetuated from year to year in a locality, ascribing it to a physician recommending the burial of all typhoid excreta and the

execution of this direction by a favorite nurse. It is well known that soil infected by these germs may be the origin of new cases, and Dr Veeder significantly observes that the annual recurrence of typhoid fever in the above noticed locality ceased with the death of the two parties mentioned above and a change in the method of disposing of typhoid discharges. The germs producing other intestinal disorders are discharged from the system, though presumably not persisting for such extended periods. It is well known that the bacilli causing tuberculosis are abundant in the sputum of patients and are therefore, under the prevalent sanitary conditions, easily accessible to flies.

The house fly subsists entirely upon fluids and feeds with apparently equal gusto upon fresh manure, decaying vegetable matter, sputum or the daintiest culinary preparations. It is only necessary for discharges from patients suffering from typhoid fever or other intestinal diseases to be exposed in open vessels, poorly constructed privies, or even in vacant lots near dwellings in order to secure the spread of the infection. The hairy legs are fouled with thousands of deadly bacilli and countless numbers are swallowed. Shortly thereafter the flies may appear in the house and incidentally contaminate the food, to the great peril of the consumer, with the germs adhering to the limbs and those deposited with undiminished virulence in the familiar fly specks. This, while disgusting and abhorrent to every sense of decency, occurs repeatedly and is apparently ignored by the masses, despite the deadly peril thus incurred. One fly, after having fed upon contaminated matter, may carry many more bacilli than usually occur in gallons of infected milk or water.

Habits. The house fly breeds by preference in horse manure, though it lives to a limited extent in cow manure and miscellaneous collections of filth, especially decaying vegetable matter. The flies deposit their eggs upon manure and similar material, the maggots hatch in less than 24 hours and, under favorable conditions, complete their growth in 5 to 7 days. The white conical maggots some half an inch long then transform to an oval, brown, resting or pupal stage, remaining in this condition from 5 to 7 days. The life cycle is therefore completed in 10 to 14 days, the shorter period being true of the warmer parts of the year, particularly in the vicinity of Washington, D. C. One fly may deposit 120 eggs, and as there may be 10 or 12 generations in a season, it is not sur-

prising that this insect should become extremely abundant by midsummer. It has been estimated that 1200 house flies might be bred from a pound of manure, and at this rate a good load would produce two and one half million. Fortunately, breeding is confined to the warmer months, only a few flies wintering in houses in a more or less dormant condition.

Ordinarily, flies do not travel a great distance and, in most instances, probably breed within 300 to 500 feet of places where they are extremely abundant. Butcher carts, grocery wagons and electric or steam cars carrying more or less exposed meat and other supplies attractive to flies, may become important agents in the dissemination of disease, since it is only necessary for these vehicles to load where conditions are favorable for fly infection and we may have a mysterious outbreak of disease at some distance from the source of trouble.

Natural enemies. The house fly, though so abundant, is subject to attack by various natural enemies. One of the most common is a fungous disease known as Empusa muscae which is occasionally responsible for the death of many flies, particularly toward the end of summer. It is not uncommon to find a few individuals affected by this disease every year. A small, reddish mite may be occasionally found attached to flies, seriously weakening the host. There are, in addition, wasps and spiders which prey upon flies and undoubtedly are of considerable service though they are very rarely sufficiently abundant to materially reduce the numbers of this pest. Another interesting enemy of the house fly is known as the house centipede,[1] a harmless species which, in recent years, has become well established in many houses in New York State. It is credited with preying on house flies, cockroaches and presumably other insect inhabitants of dwellings.

Sanitary measures. The first essential is to prevent the spread of disease by the prompt disinfection of all discharges, both fluid and solid, from typhoid and other fever patients, thus preventing so far as individual cases are concerned, the possibility of fly infection. Such treatment should include all affections where there is even a remote possibility of insects or other agents carrying disease from one person to another. A very cheap and effective disinfectant, according to Dr Veeder, is a strong solution of the common blue vitriol or sulfate of copper, a few pounds being sufficient for a hogsheadful of disinfectant.

[1]Scutigera forceps Raf.

It is hardly necessary to add, in view of the foregoing, that the greatest care should be taken to exclude flies from the sick room, especially in the case of contagious diseases. These pests not only annoy the patient but may aid in carrying the germs to others. Accumulations of exposed fecal matter in the vicinity of human dwelllings should not be tolerated, since disease can be easily contracted from such sources. Swill barrels should always be provided with tight covers and care exercised that there be no leakage or accumulation of fly-breeding material about the barrel. The old-fashioned box privy should be abolished unless it is conducted on the earth closet principle and the contents kept covered with lime or dry earth, so as to prevent both the breeding and infection of flies. In this connection it should be remembered that deposits of human excrement in the open are equally dangerous. The modern water-closet and cesspool is by far the best and safest method of caring for these wastes. Such conveniences — one might well term them necessities — are no more costly than a long run of fever with its attendant suffering and occasional death.

It is obviously impossible to distinguish between flies bearing disease germs and others. Consequently, it is extremely desirable to keep these pests from all food, particularly that to be eaten without having been cooked. This is especially true of milk, since it affords a favorable medium for the multiplication of certain disease germs. It applies to dealers in food supplies as well as to the home. A movement for the better protection of food supplies, now being pushed so vigorously by the Consumers' League in New York city, might well be extended to other localities. This important step toward better sanitary conditions would receive an additional impetus if the public refused to patronize provision stores, restaurants and hotels overrun by flies.

Control measures. The foregoing account justifies the assumption that numerous flies may be construed as indicating a nearby and usually easily eliminated breeding place. It should be observed at the outset that these insects multiply most readily in moist, organic matter, preferably in light places, and that at least 10 days are necessary before the life cycle can be completed. Domestic animals are still a necessity, though it does not follow that the manure from stables must be thrown outdoors and allowed to produce myriads of flies throughout the warm months, a condition frequently obtaining in the country. It is not necessary that

this material be stacked for weeks in partly open cellars or back yards connected with village or city stables. Common experience and experiments by the writer show that flies rarely invade darkened places. One of the most fly-beridden situations we chanced across the past summer was an open barn cellar containing a mass of sloppy manure in a hog pen. Such conditions should never be allowed to exist. Manure can and should be stored in a fly-proof receptacle. This may be a tightly covered pit outside the stable or a cellar so dark or so tight that flies will not or can not enter. Both are relatively easy to construct with our modern concrete walls, matched lumber and cheap building paper. Even should eggs be deposited in the manure prior to its being placed in any such receptacle, it would be comparatively easy to provide, at the farther end of such cellar, pit or vault, a tightly screened light fly trap. Any flies issuing from the manure would enter the trap, and comparatively few escape to the stable. It is entirely practical to make similar provision for the care of other fly-breeding materials, such as table scraps, decaying fruit, etc.

Conditions may render it practically impossible to provide such a fly-proof receptacle. Experiments have shown that horse manure treated each morning with a small amount of chlorid of lime will not produce flies. A cheap material which, according to Prof. W. B. Herms of California, may be used for the destruction of the maggots in manure, can be prepared by dissolving one half pound of caustic potash in a half pint of water. Stir the cold solution and at the same time add one quart of linseed oil and stir at about hourly intervals for four or five hours and then allow the mixture to stand over night. Next, add one and one fourth quarts of commercial cresol to the soap formed and dilute the slowly formed solution with 20 parts of water. Three or four days may be necessary to effect a complete solution. Poultry should not be allowed to feed on maggots killed in this manner. It is very probable that some of the so called " soluble " or miscible oils, now on the market under various trade names, could be used for this purpose, the dilution being about one to ten.

It will be seen by referring to the habits of the house fly that it is impossible for this insect to produce a generation inside of 10 days, consequently the frequent removal, at approximately five day intervals, of manure and other fly-breeding material will prevent the multiplication of this insect, provided the work is thoroughly

done. This is entirely practical in many places and in accord with the best agricultural practice. Sanitary regulations of the District of Columbia permit the keeping of manure in barrels, provided it is tightly packed and removed within a certain period. Manure spread upon the field dries out so rapidly that the insects are unable to complete their transformations. The persistence of flies in localities where this practice prevails, means that certain breeding places have been overlooked and, as a rule, the evil can be corrected without great expense. There is no reason why stables and barns on farms in particular, should be located so near the house as to cause serious trouble on account of flies. One or more of the above measures is applicable to every stable in cities and villages and should be practical under most farm conditions.

It will be found in practice that some flies are very apt to exist in a neighborhood even after the adoption of rigid precautions. They should be kept out of houses, so far as possible, by the use of window and door screens, supplemented by the employment of Tanglefoot or other sticky fly-paper, or better yet, a sweetened 5 to 8 per cent solution of commercial formaldehyde. This latter should be renewed from day to day and exposed in saucers or other shallow dishes in places where flies are most abundant. A 40 per cent solution of formaldehyde can be purchased in drug stores, and if diluted with five or six times its volume of water, will give the desired strength; add a little sugar or other sweet. This material is somewhat expensive but much preferable to arsenical or cobalt poisons so extensively used against flies. Fresh pyrethrum powder placed upon window sills has also been highly recommended.

The control of this pest is of great importance to the community. Individual effort in this direction should be strengthened and sustained by all officials charged with protecting the public health. The Health Department of Washington, D. C. has already promulgated excellent ordinances against the fly pest. Similar action should be taken by health officials in our municipalities and villages.

Fruit flies

These light brown flies, only about 1/8 of an inch long, are most commonly found about the pomace of cider mills and on overripe or partly decaying fruit. They are attracted by fermented liquids, such as wine, cider, vinegar, beer, and may frequently be observed on the sides of jars containing preserved fruits. There are two

species[1] which appear to be most abundant. It is very difficult to keep these insects out of houses on account of their small size. Dr Howard has listed these forms as likely to be disease carriers.

These little insects rarely enter the house unless attracted by overripe or canned fruit. The latter should be hermetically sealed, making it safe from injury, and stored in the cellar or other place comparatively inaccessible to the flies, as soon as convenient. These small flies can easily be destroyed with fresh pyrethrum powder.

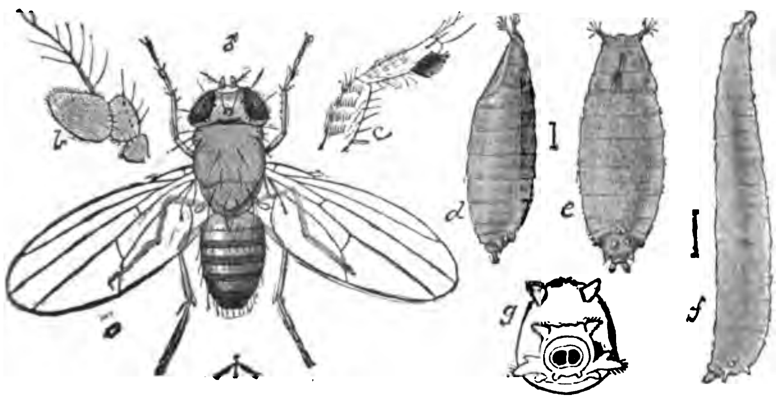

Fig. 2 Fruit fly: *a*, adult fly; *b*, antenna; *c*, base of tibia and first tarsal joint; *d*, puparium, side view; *e*, same, dorsal view; *f*, larva; *g*, anal segment of same; *a*, *d*, *e*, *f*, much enlarged; *b*, *c*, *g*, still more enlarged. (After Howard, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

Malarial mosquito[2]

This is one of our native species. It is only recently that its connection with the spread of malaria has been established beyond question, though there has long been a suspicion that some mosquitos might be responsible for this disease.

Infection by malaria. Medical men, best qualified to pass upon the question, unhesitatingly affirm that certain mosquitos are responsible for the dissemination of this malady. Malaria, like some other diseases, is caused by a specific germ. It is peculiar in that it has to pass through certain changes within the body of the mosquito before it can develop successfully in the human system. Moreover, malarial mosquitos are harmless until they have become infected by biting some person suffering from

[1] Drosophila ampelophila Loew and D. amoena Loew.
[2] Anopheles maculipennis Meign.

this disease. These germs may be carried by man in a latent condition for years. This is especially true of Italians. The sequence of events may be briefly summarized as follows: A female mosquito bites a person having malarial germs in his blood. The malarial parasites enter the walls of the mosquito's stomach, undergo certain changes therein, and in from 7 to 14 days make their way to the salivary glands and are then ready to enter the system of the next person bitten. These germs then undergo a series of changes, and if the person is not immune a more or less severe case of malaria develops. So far as known, the malarial mosquito, and that only, can carry this infection. The connection between malaria and extensive excavations has long been recognized, though it is only recently that a satisfactory explanation of this condition has been advanced. Malarial mosquitos breed in large numbers in pools in and about excavations. Italians are our principal excavators. Most of them have suffered from malaria and have the disease germs

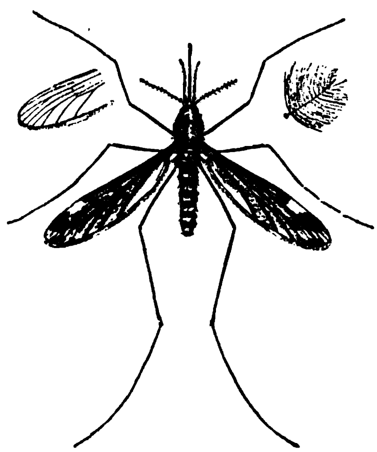

Fig. 3 Malarial mosquito, female, with male antenna at right and wing tip showing venation at left. (Reduced from Howard, U. S. Dep't Agric. Div. Ent. Bul. 25. n. s. 1900)

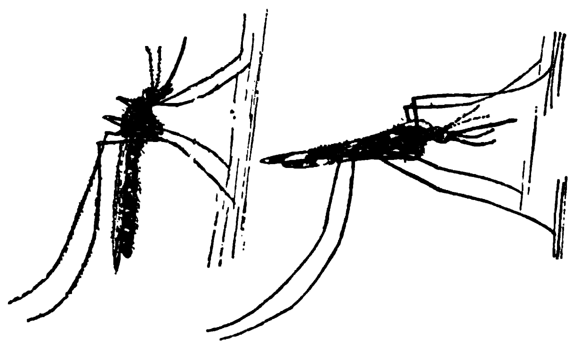

Fig. 4 Common and malarial mosquitos at rest, the latter to the right. (Reduced from Howard, U. S. Dep't Agric. Div. Ent. Bul. 25. n. s. 1900)

in their systems. The malarial mosquito, breeding in large numbers about recent excavations, derives its infection from the Italians and then, if opportunity allows, inoculates Americans. We

therefore frequently have exceptionally severe outbreaks of malaria following extensive excavations. This is exactly what would be expected if the above statements are true.

Appearance and habits. The appearance and habits of the malarial mosquito are important if we wish to avoid malaria. This peculiar form is easily recognized by its spotted wings and, in particular by the characteristic resting position, the beak and the body being in almost a straight line and at a considerable angle to the supporting surface. On the other hand, our ordinary mosquitos do not have spotted wings and when at rest the beak and the body form an obtuse angle, the body being approximately parallel with the supporting surface. The wriggler of the malarial mosquito occurs in grassy pools, beside streams and is frequently very abundant in collections of water in and about recent excavations. The wriggler of the malarial mosquito is easily recognized by the absence of a conspicuous air tube, by its resting in a horizontal position just beneath the surface film, and the usually bright or dark brown and greenish colors. The wrigglers of the common mosquito, conversely, have a large air tube at the posterior extremity, invariably rest with the body at a considerable angle to the surface of the water and are a dull whitish or yellowish white. The malarial mosquito breeds more or less during the warm months of the year, the spotted-winged adults wintering in any shelter, frequently in houses and occasionally flying in midwinter. The capture of chilled specimens on snow banks in early spring is not unusual.

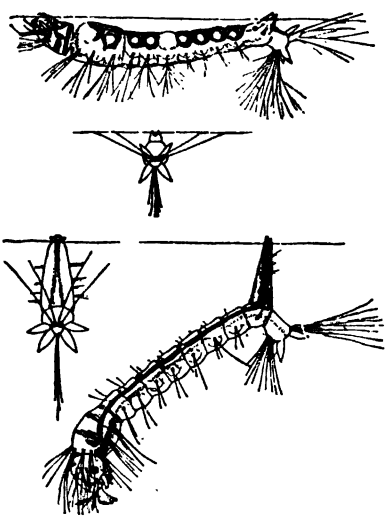

Fig. 5 Characteristic feeding position of malarial mosquito wriggler in upper figure, and that of the common mosquito in lower figure. (Reduced from Howard, U. S. Dep't Agric. Div. Ent. Bul. 25. n. s. 1900)

Control measures. Malarial outbreaks may be prevented or controlled in two ways. The malarial mosquito is very local in its habits. It is comparatively easy, by draining breeding pools and treating those not easily drained, with oil, to eliminate the mosquito and thus do away with all danger of infection. This is

practicable in most cases and in sections where malaria is more or less prevalent, is the only course to pursue.

The malarial mosquito is widely distributed in the North and there is always a chance of an outbreak following the appearance of parties suffering from malaria or having the parasite in their blood, as for example, Italians. The advent of either in a neighborhood should be preceded if possible by extraordinary activity in draining or treating breeding places in order to destroy as many of the insects as possible and thus reduce the danger of infection. Methods of value in controlling common mosquitos will be equally serviceable in checking this disease carrier.

Yellow fever mosquito[1]

This, though a southern species, is of interest owing to its great economic importance. It is a dark brown form, marked with strongly contrasting silvery white, and is frequently designated as the day mosquito in the South.

Yellow fever carrier. This insect appears to be the only agent by which yellow fever may be conveyed from one person to another. As in the case of the malarial mosquito, the yellow fever mosquito is harmless until it has become inoculated with the germs by biting a yellow fever patient, and even then some 12 days must elapse before it can convey the infection. As a result of the recent discoveries relating to this insect, the control of a yellow fever outbreak means a strenuous, well sustained campaign against mosquitos, supplemented by the exercise of special care to prevent their gaining access to yellow fever patients.

Habits and control. The yellow fever mosquito appears to have in the South much the same habits as our house mosquito in the North. It displays a marked preference for the water in cisterns, tanks and similar places; consequently measures of value in reducing the house mosquito will prove equally serviceable in controlling this much more dangerous southern species.

Bedbug[2]

The brown, oval, flattened, malodorous insect so generally designated by the above name, is too familiar to require description. It is especially likely to be abundant in old houses where cracks and crevices abound, and its continuance therein is favored by

[1] Stegomyia calopus Meign.
[2] Cimex lectularius Linn.

the old style wooden bedstead with its numerous shelters. The occurrence of this pest in a home is not necessarily a reflection upon the ability of the housewife. Its continuance there may be the occasion of grave reproach. Bedbugs are very liable to occur on boats, are occasionally found in sleeping cars and are said to be much more common in the Southern than in the Northern States. This pest has been connected with the dissemination of several diseases.

Habits. This insect, as many can vouch for by personal experience, is nocturnal in habit. Recent experiments show that it may feed under certain conditions on mice as well as upon man. This

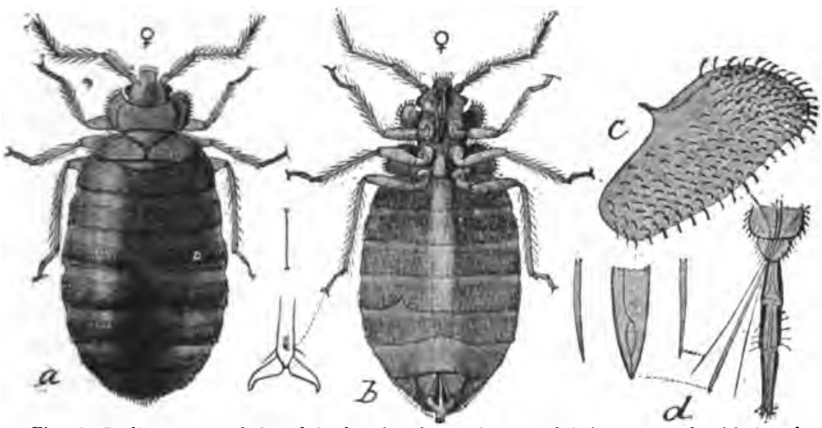

Fig. 6 Bedbug: *a*, and *b*, adult females from above and below, gorged with blood; *c*, and *d*, structural details. (After Marlatt, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

habit, should it prove to be general, accounts for cases where bedbugs are found very abundant in houses which have been uninhabited for some time. Another species[1] occurs in swallows' nests and occasionally invades adjacent living rooms. It appears to live almost exclusively upon birds, though a third form,[2] found on chickens, has been known to suck human blood, but not under natural conditions.

The oval, white eggs of the bedbug are deposited in cracks and crevices in batches of 6 to 50 or thereabouts. The yellowish white, nearly transparent young hatch therefrom in a week or 10 days. Experiments have shown that about 11 weeks are necessary for the young insects to attain maturity, though the period is probably greatly modified by the degree of warmth and the

[1] Cimex hirundinis Jenyns.
[2] Cimex columbarius Jenyns.

abundance of food. It is said that ordinarily only one meal is taken between each of the five molts preceding the attainment of maturity. Full-grown bugs at least are able to endure long fasts with apparently no inconvenience.

Control measures. Cracks and crevices, loose wall paper and the old wooden bedsteads afford ideal hiding places for this disgusting pest. The modern tight construction of both floors and walls, and iron or brass bedsteads reduce the retreats of this species to a minimum and greatly facilitate its control.

The insect can be controlled in the older type of dwelling only by extreme vigilance. Cracks and crevices should be stopped so far as possible, and the joints of the old-fashioned bedstead treated liberally with benzine, kerosene or similar oils. Hot water can be employed for cleansing bedsteads where this treatment seems preferable. Corrosive sublimate is frequently used, though a deadly poison and should be employed with great caution. The daily inspection and the destruction of bugs found on the bed and bedding soon results in eliminating the pest unless the building affords comparatively inaccessible retreats, as, for example, a very defective floor.

A room badly infested by this pest might well be thoroughly fumigated with brimstone; 2 pounds of sulfur are advised for each thousand cubic feet of space, the treatment being continued at least 24 hours if possible. The sulfur candles now manufactured are excellent for this purpose. A more effective though much more dangerous method is the employment of hydrocyanic acid gas, directions for the use of which are given on page 48. This latter is especially serviceable where entire buildings are badly infested.

It may be comforting to know that the bedbug has active enemies in the little red ant and also cockroaches. Unfortunately these insects are serious nuisances in the household and hardly more welcome than the pest under consideration.

ANNOYING FORMS

Cluster fly

This interesting species[1] has received its popular name because of the large clusters occasionally found in autumn in houses. It is easily distinguished from the rather closely related house fly by the black thorax covered rather thickly with tawny hairs frequently inclining to a grayish shade. The young of this species live about

[1] Pollenia rudis Fabr.

the roots of grasses and there is a record of its having been reared from cow dung. Clusters of this insect can easily be destroyed by dusting the flies liberally with fresh pyrethrum or insect powder. The insecticide may be molded into moist cones and burned if preferred. The stupefied flies, in either case, should be swept up and burned.

Wasps and hornets

Fig. 7 Wasp enlarged. (After Riley)

The paper wasp[1] and the common wasp[2] frequently occur about buildings and are of considerable service in destroying flies. Occasionally, if exceptionally abundant, they may become a nuisance on account of the danger from stinging. These insects can easily be excluded by the use of screens and in case of their being excessively abundant, the nests should be found and the inmates destroyed at night with chloroform or bisulfid of carbon.

House or rain barrel mosquito[3]

This modest, brown, though by no means retiring mosquito, hardly needs an introduction. Its suggestive song is so well understood that we instinctively prepare for the inevitable. This mosquito takes advantage of man at every possible opportunity, while we tamely submit to a series of annoyances which could be eliminated at a less expenditure of energy than is necessary to endure repeated trials of patience with a reasonable degree of fortitude.

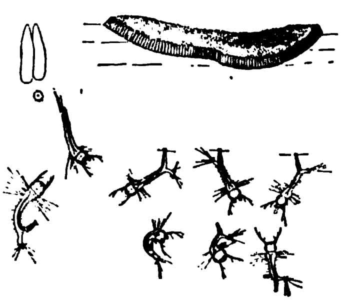

Fig. 8 House mosquito. Egg mass with enlarged eggs above and at the left; young wrigglers below. (Reduced from Howard, U. S. Dep't Agric. Div. Ent. Bul. 25. n. s. 1900)

Habits. This insect winters in small numbers in houses or other shelters, the females depositing clusters of eggs upon standing water on the approach of warm weather. Breeding may continue

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[1] Vespa germanica Fabr.
[2] Polistes sp.
[3] Culex pipiens Linn.

under favorable conditions till checked by frosts in the fall. This domestic pest displays a marked partiality for water in rain barrels, cisterns, defective eave troughs, old wooden buckets, tin cans or similar receptacles. The black eggs are deposited in raftlike masses of some two to four hundred, and the entire development to the adult may occur within 14 days. One rain barrel may produce thousands of mosquitos and provide an abundance of these ubiquitous annoyances throughout a season.

Control. This species, like a number of other mosquitos, is quite local in habit and its presence may be construed as an indication of nearby breeding places. The elimination of useless barrels, tin cans, etc. will accomplish much toward reducing the numbers of this pest, and this should be supplemented by attention to gutters and eave troughs to see that they have not become bent or clogged so as to afford breeding places. Rain barrels and cisterns, if a necessity, may be rendered innocuous by covering them closely, even though nothing more substantial than mosquito netting be employed. Should this latter be undesirable, the surface may be kept covered with a film of kerosene, without detriment to the employment of the water for domestic purposes, provided the water be drawn from the lower part of the vessel.

Salt marsh mosquito[1]

The salt marshes, as might be presumed, present peculiar conditions and these are accompanied by a corresponding variation in animal life. Those at all familiar with marsh conditions have learned by experience about the large, voracious swarms of mosquitos which may occure in such sections.

Habits. The salt marsh mosquito is typical of several forms which breed by preference in brackish water. The short tubed, dark colored wrigglers are found here and there in pools, being by far the most numerous within two or three hundred feet of the high land, this area being that portion of the marshes flooded only by high tides. These more or less regular overflows of water result in numerous eggs hatching and the production of ravenous hosts of mosquitos, easily recognized by their white banded legs, beak and body, the latter in addition, bearing a conspicuous longitudinal white stripe. These insects differ greatly from our house mosquito, in that they fly considerable distances, there being authentic records of their having been found 40 miles from the

[1] Culex solicitans Walk.

nearest available breeding place. Occasionally hosts of these insects invade New York city to the great discomfort of the residents.

Control. The control of this species is practicable though at the outset it appears somewhat difficult. All that is necessary is to provide drainage so that pools of water will not stand more than a few days. This is accomplished by running narrow ditches within about 25 feet of the headland and 40 or 50 feet apart, all being connected with some tidal creek so that they are flushed out twice daily. The walls of the ditches should be perpendicular and the bottom at a uniform level. Experience has shown it inad-

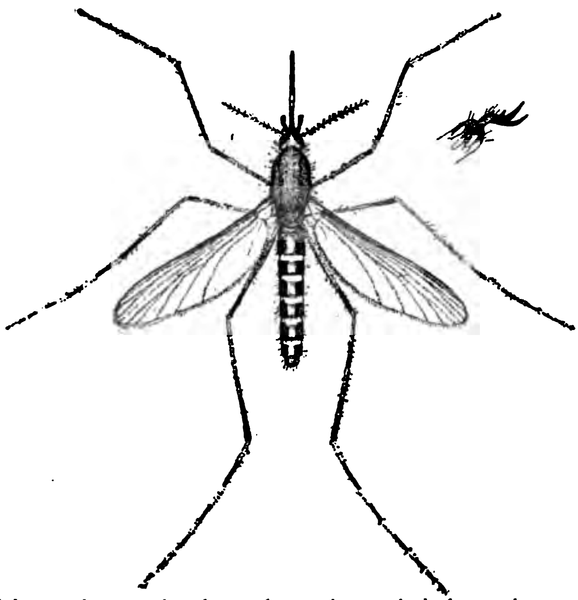

Fig. 9 Salt marsh mosquito from above, the toothed front claw more enlarged. (After Howard, U. S. Dep't Agric. Div. Ent. Bul. 25. n. s. 1900)

visable to have the walls sloping or to attempt to secure a uniform pitch, since the latter almost invariably results in pools not reached by the daily tides. This work has been conducted on an extensive scale in the vicinity of New York city with most gratifying results. Several types of ditching machines are in use and the work is comparatively inexpensive.

The elimination of mosquito breeding places on the salt marshes may sometimes be accomplished by the use of tidal gates and a series of drains. This method, while thoroughly effective, belongs to the domain of land development rather than to that of insect

subjugation. The additional cost in many cases may be more than met by the increased value of the marshes treated.

House fleas

The cat and dog flea[1] is the species most usually abundant in houses in New York State, judging from the specimens submitted with complaints. This species, as its common name indicates, occurs indiscriminately upon both the cat and the dog and may be found about their sleeping places. The minute, white eggs are laid mostly in such places. The slender, active larvae feed upon organic matter in cracks and crevices, and are most numerous

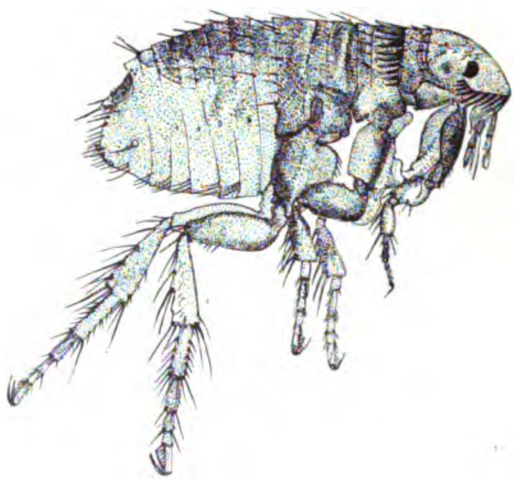

Fig. 10 Cat and dog flea, seen from the side, enlarged. (Original)

about the sleeping places of domestic animals. The flea is a prolific insect. The closing of a dwelling for several weeks or more in warm weather affords almost ideal conditions for rapid multiplication, and more than once householders have been surprised on returning to find the home overrun by these active, annoying pests. A rat flea is an important factor in the spread of bubonic plague.

Control measures. Fleas are very likely to occur on cats and dogs and if these animals must be retained in the home, care should be exercised to keep their sleeping places clean. Provide

[1] Ctenocephalus canis Curtis.

the animal with a mat or blanket upon which it may sleep. This mat should be taken up frequently, shaken and the collected dust beneath burned. This is a most effective method of preventing the multiplication of these insects. An animal known to be infested with fleas should have a quantity of fresh pyrethrum powder rubbed into the hair. This will stupefy the pests, causing them to drop off and then they may be swept up and burned. Dusting hosiery with pyrethum powder has been found very effective in preventing flea bites in situations where such precautions are advisable.

It is frequently very difficult to deal with a bad infestation, due to the impossibility of getting at the breeding places or destroying all of the fleas at one time. Dr Henry Skinner of Philadelphia states that he has successfully destroyed fleas in a badly infested room, by sprinkling the floor liberally with about 5 pounds of flake naphthalene and closing the room for 24 hours. The acrid fumes destroyed the fleas and inflicted no material injury. There is no danger in this procedure and we earnestly commend it to those troubled by this pest. Fumigation with hydrocyanic acid gas, described on page 48, where practical, is a most satisfactory method of dealing with this condition.

Bedbug hunter

This species[1] occasionally occurs about houses and with one or more allies was widely noticed by newspapers in 1898 under the name of kissing bug. This brownish or black insect is about ¾ of an inch long and has somewhat the same shape as the malodorous squash bug of the garden. It is beneficial, since it preys upon insects. The grayish, sprawly legged young are unusually interesting on account of their being covered with particles of lint. This gives them a nondescript appearance and undoubtedly is of service in enabling them to creep up unobserved upon their prey.

Fig. 11 Masked bedbug hunter or kissing bug, from above, about twice natural size. (After Howard, U. S. Dep't Agric. Div. Ent. Bul. 22, n. s. 1900)

[1] Opsicoetus personatus Linn.

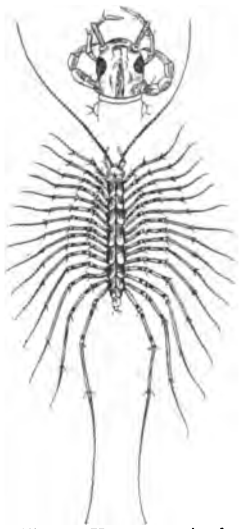

Fig. 12 House centipede; seen from above, enlarged, the head still more enlarged. (After Wood)

House centipede[1]

This light brown, rapidly running, sprawly legged centipede arouses more or less aversion and terror through apprehension. Like other centipedes, it is capable of inflicting a somewhat poisonous bite though, as a rule, it is only too glad to escape. The house centipede has become well established in the dwellings of Albany, N. Y., and is presumably more or less abundant in other cities of the State. It is beneficial in that it is known to prey upon house flies, cockroaches and other insects. Its presence in a house should be welcomed, since it is capable of inflicting no injury aside from a somewhat poisonous bite, the latter being extremely rare.

FABRIC PESTS

Clothes moths

The small, white caterpillars of these insects, frequently in a cylindric, webbed case, are very different from the young of the

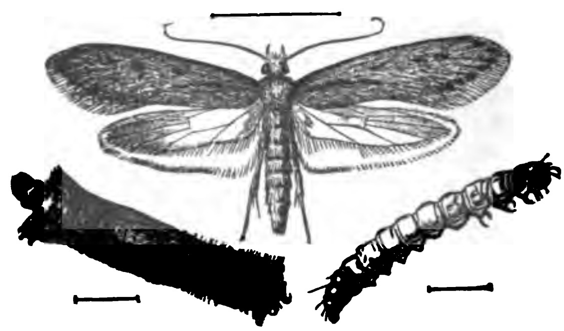

Fig. 13 The common case-making clothes moth; adult; larva and larva in case; enlarged. (After Riley)

carpet beetles noticed on page 30, one of which is frequently referred to as the Buffalo clothes moth. The true clothes moths

[1]Scutigera forceps Raf.

are small, grayish yellow moths or millers, indistinctly dark spotted and having a wing spread of less than half an inch. The progeny of not all small moths are injurious to fabrics, though several such destructive species occur in this State.

Description and habits. The most common form in New York State is known as the case-making clothes moth[1] easily recognized in the immature stage by the cylindric case which the small caterpillar drags around as it moves from place to place.

The webbing or southern clothes moth[2] is stated to be the more abundant and injurious species in the latitude of Washington though it occurs farther north. This species is about the same size as the preceding and has uniformly pale yellowish wings. The young or caterpillar does not construct a case but lines its runways with fine silk. This destructive caterpillar feeds on a variety of animal materials, having been found in woolens, hair, feathers and furs, and is frequently a troublesome pest in museums.

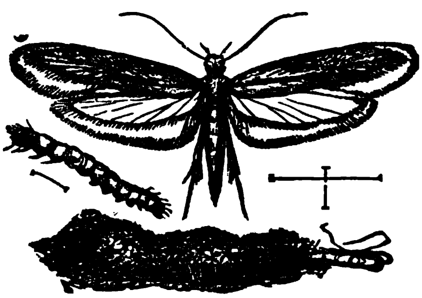

Fig. 14 Webbing or southern clothes moths: adult, larva, cocoon and empty pupal skin; enlarged. (After Riley)

The tapestry moth[3] is rare in this country and is larger than either of the other two, having a wing spread of about ¾ of an inch. The base of the forewings is black, the outer portion being a variable creamy white. This larger species displays a marked preference for the heavier fabrics, such as carpets and horseblankets and may be found in felting, furs, skins, carriage upholstering, etc.

Fig. 15 Tapestry moth: adult, enlarged. (After Riley)

Control measures. Clothes moths, like carpet beetles, fleas and some other household pests, thrive best in situations where there is relatively little disturbance. Clothing used almost daily and other fabrics subject to frequent handling, brushing or sweeping

[1] Tinea pellionella Linn.
[2] Tineola biselliella Hum.
[3] Trichophaga tapetzella Linn.

are relatively immune from injury. Woolens and furs are most likely to be damaged while in storage during warm weather. These, before being laid away, should be thoroughly aired, brushed and carefully examined for the presence of the destructive larvae. Then they should be packed in cedar chests or tight boxes, preferably with some naphthalene or camphor, as these latter materials are of some service as repellents. A very effective and cheap method of storing articles for the summer is to put them in tight pasteboard boxes and seal the covers firmly with strips of gummed paper.

Valuable furs and similar articles are frequently deposited with storage companies. Experiments conducted under the direction of Dr Howard, Chief of the Bureau of Entomology, have shown that all danger of injury by clothes moths and their associates may be obviated by keeping the temperature at about 40° Fahrenheit. This is sufficiently low so that insects, even if present, will remain in a dormant and therefore harmless condition.

Occasionally a clothespress becomes badly infested by clothes moths. All garments should then be removed, aired, thoroughly brushed and care taken to destroy any larvae which may not have been dislodged by this treatment. The clothespress itself should be thoroughly brushed and cleaned. These measures should afford relief. It is a very poor plan to have in the attic or some unused part of the house miscellaneous woolens or other materials in which the pests can breed unrestricted, as such places are likely to serve as centers for the infestation of more valuable articles. Methods of fumigating are briefly discussed on pages 22, 48–50.

Spraying with benzine or naphtha two or three times during warm weather is advisable for the purpose of preventing injury to cloth-covered furniture, cloth-lined carriages and similar articles in storage or unused for extended periods. Care should be exercised to prevent the inflammable vapor of these oils gaining access to fire of any kind.

Carpet beetles

Housekeepers of Albany, N. Y., at least, are seriously troubled by carpet beetles. These destructive insects, it will be seen by referring to page 28, are very different from the clothes moths though operating somewhat in the same manner.

Description. The Buffalo carpet beetle[1] is a stout, oval beetle ⅛ of an inch long or less and easily recognized by its black and

[1] Anthrenus scrophulariae Linn.

white or yellowish white and red mottled wing covers. The red markings form an irregular line, with three lateral projections on each side, down the middle of the back. The common name Buffalo carpet beetle is suggestive of the shaggy, stout grub or larva, some ⅛ of an inch long, found working in carpets, more generally along seams or cracks in the floor.

The black carpet beetle[1] is a more slender, black or brownish beetle somewhat larger than the oval Buffalo carpet beetle, though rarely attaining a length of 3/16 of an inch. It is peculiar on account of the greatly produced terminal antennal segment in the male. The slender, reddish brown grub some quarter of an inch or more in length, is easily distinguished from that of the Buffalo carpet beetle by the long, brushy tail of reddish hairs and the sparse clothing of the tapering body.

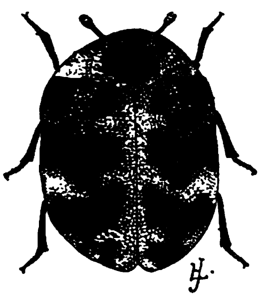

Fig. 16 Buffalo carpet beetle, seen from above, enlarged. (Original)

Habits. Both of these carpet beetles are rather common on flowers the latter part of May and early in June and may be brought into houses therewith. They also occur on windows in early spring, are found in the fall and occasionally in the winter. Both play possum when disturbed. The eggs of the Buffalo carpet beetle are deposited in convenient places and the young grubs develop quite rapidly. It is probable that there are not more than two generations in the North though the insects are active in warm houses throughout the year. The black carpet beetle has very similar habits though the development of its grub appears to be much slower. This latter insect is known to feed upon feathers and has been reared in flour and meal. Woolens are more liable to injury than other fabrics.

Control measures. Obviously it is advisable to destroy the beetles found about houses before they have had an opportunity of laying eggs. It is desirable to avoid bringing the pests into the house with flowers. Both of these insects breed in organic matter, presumably in outbuildings or outdoors, as well as within, fly to the flowers and may then, in the case of the Buffalo carpet beetle at least, be carried into dwellings before eggs[2] are deposited. The

[1] Attagenus piceus Oliv.

[2] Professor Slingerland, Rural New Yorker, 1896, 55:582, records obtaining eggs from Buffalo carpet beetles taken on flowers.

substitution of rugs or matting for carpets is advised in localities where the pests are destructive.

Infested carpets should be taken up and thoroughly cleaned. and if badly infested, sprayed with benzine. This latter should invariably be done outdoors, owing to the extreme inflammability of this oil. Local injury can frequently be stopped by passing a hot iron over a damp cloth laid on the affected part of the carpet. The steam penetrates the fabric and destroys the pest in its retreat. The danger of subsequent injury can be largely avoided by filling all cracks and crevices in poorly constructed floors with putty, plaster of paris or a crack filler. Laying tarred paper under a carpet has been frequently advised as a preventive.

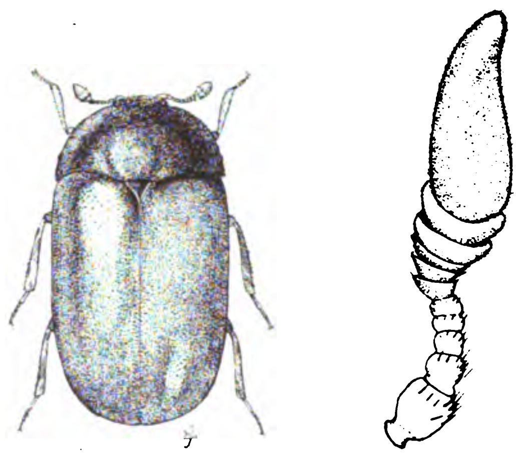

Fig. 17 Black carpet beetle, seen from above, enlarged; antenna of the male, still more enlarged. (Original)

These insects can undoubtedly be destroyed by fumigation with burning sulfur, bisulfid of carbon or hydrocyanic acid gas. The first named is frequently employed and though the fumes are very pungent, liable to blacken silver and cause other damage, particularly if considerable moisture is present, it is one of the safest fumigants. Bisulfid of carbon, on account of its inflammability, is hardly a safe material to employ in dwellings. Hydrocyanic acid gas has been used extensively in the last decade for the destruction of household pests. Directions for using it are given on page 48.

For the treatment of garments and furs stored during warm weather, see the discussion on page 30.

Silver fish, bristle tail or fish moth[1]

This peculiar, elusive insect is frequently the subject of inquiry by careful housekeepers. It is rather common about houses though rarely seen. It is about ⅜ of an inch long, silvery gray and tapering. Perfect specimens have very long antennac and three equally long appendages at the posterior extremity.

Habits. This insect feeds upon nitrogenous or farinaceous matter such as the sizing of paper, starch, paste etc. It has even been known to eat off the face of museum labels to such an extent as to render them illegible. It thrives best in places where there is comparatively little disturbance and is therefore rarely numerous in houses having few crevices and no storeroom where articles are allowed to remain undisturbed for months or even years at a time.

Control measures. This insect, if abundant, can be controlled to best advantage, according to Mr Marlatt, by slipping into their haunts pieces of paper liberally treated with a thick, boiled, starchy, preferably nitrogenous, paste poisoned with arsenic. This material should be used with extreme care and placed only where there is no danger of children getting hold of the poison. Ordinarily the dusting of this insect's haunts with fresh pyrethrum powder, followed by thorough cleaning, is preferable to the employment of an arsenical poison. Damage is most likely to occur in comparatively moist places or where articles are allowed to remain undisturbed for a year or more.

Book louse

This is a pale louselike insect[2] only 1/25 of an inch long and frequently designated as the "death watch" because of the peculiar ticking sound it makes. This latter is supposed to predict an early death in the family. An allied species[3] has similar habits and is considered to be the true "death watch." Both of these species, as well as allied forms, live upon vegetable matter and occasionally may become very abundant. There have been several records of this insect issuing in enormous numbers from mattresses stuffed with hair, corn husks or straw. An infestation of this kind can be controlled best by removing and burning the infested mattress. The apartment then should be thoroughly cleaned.

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[1] Lepisma domestica Pack.
[2] Atropos divinatoria Fabr.
[3] Clothilla pulsatoria Linn.

White ants[1]

These insects, despite their general resemblance to the more common ants, are very different creatures. The flying ants, though having somewhat the same size as some of our winged, black ants, may be recognized at once by the numerous veins of the wings. White ants are frequently very injurious to buildings or their contents, particularly in Washington and to the southward. Occasionally they cause serious injuries in New York, and in at least one instance established themselves in safe deposit vaults and proceeded to destroy valuable records and to tunnel the wooden blocks of electrotypes. The whitish, wingless, antlike forms make large tunnels in woody and other vegetable fibers,

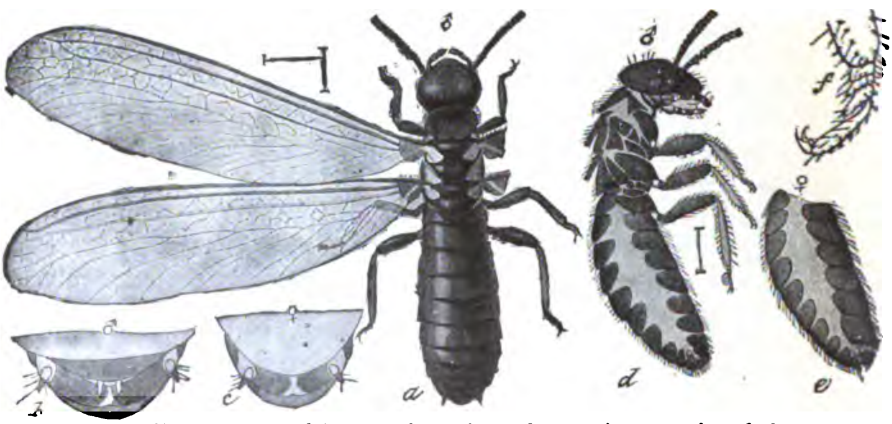

Fig. 18 White ants: *a*, adult male from above; *b*, posterior extremity of the same from below; *c*, the same of the female; *d*, male seen from the side; *e*, side view of the abdomen of the female; *f*, tarsus showing the segments and the claw; *a*, *d*, *e*, are enlarged; *b*, *c*, *f*, greatly enlarged. (After Marlatt, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

invariably avoiding the light. They pass from one object to another only through covered galleries. The secrecy with which these pests operate enables them to cause extensive injury before their presence is suspected. These peculiar insects are familiar to many who have observed their operations in an old stump.

Control measures. Nothing but the most thorough work will clean a building or a vault of these insects, because their burrowing habits enable them to get beyond the reach of destructive gases. An infested vault should have everything removed, every crack and crevice thoroughly cleaned and then special attention given to doors or other means of entrance, to see that there is no possi-

[1] Termes flavipes Kollar.

bility of insects entering through an unsuspected crevice. Before replacing the contents of the vault, wood, papers or other materials likely to be infested should be most carefully examined and, if necessary, thoroughly heated or repeatedly fumigated with some gas. Great care should be exercised to prevent the reinfestation of any such place. It is even more difficult to control this pest in buildings, since if it becomes abundant nothing can be done aside from installing brick, stone or concrete foundations. This form of construction is especially advisable in warmer sections of the country. Where books, papers and exposed woodwork only are infested, thorough and protracted fumigation with hydrocyanic acid gas, described on page 48, may be advisable.

Crickets

These black, chirping, nocturnal insects[1] occasionally make their way into houses and for the most part are welcome. Sometimes they may cause serious injury. Dr Lintner records a case where a suit of clothes, just from the tailor, was completely ruined in a night by the common black field cricket[2] which had entered an open window in some numbers. Such injury is exceptional. Crickets can be destroyed where necessary by the use of ground-up carrots or potatoes to which a liberal amount of arsenic has been added. They may also be caught by taking advantage of their liking for liquids and placing low vessels containing beer or other fluids about their haunts.

FOOD PESTS

House ants

There are several species of ants likely to occur in houses. These little insects are not specially destructive nor obnoxious aside from their faculty of getting into everything.

The little red ant[3] is particularly troublesome, since its small size, it being only about 1/16 of an inch long, enables it to enter almost any receptacle not hermetically sealed. Furthermore, this little pest is very prolific and occasionally literally overruns buildings to the serious discomfort of the inhabitants. This tiny species is perhaps the most common and the most abhorred of all, owing to the difficulty of eradicating it.

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[1] Gryllus domesticus Linn. and others.
[2] Gryllus luctuosus Serv.
[3] Monomorium pharaonis Linn.

The little black ant[1] is about ¼ of an inch long and though normally occurring under stones in yards, also invades the house in considerable numbers.

The pavement ant[2] is about ⅜ of an inch long and is very common along the Atlantic seaboard.

The large, black ant[3] is the giant among our household ants. It may be half an inch or more in length, is normally a wood feeder and has frequently been designated as the carpenter ant. This large species occasionally invades buildings, particularly in the country, lives in the timbers and makes systematic levys upon the food supplies of both kitchen and pantry. Occasionally this species may become very abundant in a dwelling.

Control measures. A house badly infested by ants, particularly if a rather old building, might well be thoroughly fumigated with

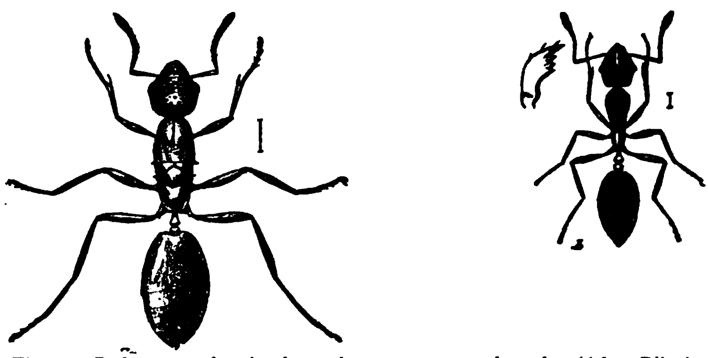

Fig. 19 Red ant: *a*, female; *b*, worker or neuter, enlarged. (After Riley)

hydrocyanic acid gas, directions for which are given on page 48. This method of treatment is especially good for the little red ant, because its nests are usually in the walls of the building and therefore inaccessible.

Aside from the fumigation mentioned above, the next most satisfactory method of controlling these pests is to search for their nests and destroy them so far as possible. This can be accomplished only by ascertaining the origin of the continuous stream of ants and is frequently impossible. The little black ant and the pavement ant are very likely to build nests outdoors under stones. Should the nests be found they can be destroyed by liberal applications of boiling water or spraying with kerosene. Outdoor nests

[1] Monomorium minutum Mayr.
[2] Tetramorium caespitum Linn.
[3] Camponotus herculeanus Linn.

of ants can be destroyed by the use of carbon bisulfid. Make a hole several inches deep with a broom handle and put therein about 1 ounce of carbon bisulfid and cover quickly. In the case of a large nest, several holes should be made at a distance of a foot or a foot and a half and each charged with carbon bisulfid. A more recent method is scooping out a portion of the soil and filling the cavity with a solution of cyanide of potassium, using 1 ounce of this deadly poison to a gallon of water. Another probably equally effective method is the sprinkling of the surface of the nest with fine particles of potassium cyanide. This material, it should be remembered, is a most dangerous poison and every precaution should be taken to avoid disastrous results. The nests of the large black ant are usually found in timbers, such as studding in the walls and are therefore wellnigh inaccessible. The writer has seen 2 x 4 joists badly riddled by the operations of this insect.

Trapping the ants by means of sponges dipped in sweetened water is frequently advised and gives good results if conscientiously carried out. First, attractive foods should be removed, so far as possible, prior to the distribution of the pieces of sponge saturated with sweetened water. These latter should be gathered from time to time and the ants clinging thereto destroyed by dropping in boiling water.

Cockroaches

Cockroaches and their smaller cousins, the croton bugs, are frequently the bane of the neat housekeeper, particularly in old city dwellings. These species are distributed through commercial agencies and have become well established in most large cities and villages on the principal routes of travel, especially seaports and places on rivers or canals, since these pests are invariably found on ships and boats. The old houses with their numerous inaccessible crannies and crevices afford a multitude of hiding places and enable the roaches to exist year after year, in spite of strenuous efforts to exterminate them.

Description. At least three species of cockroaches may be found in houses. The American cockroach[1] is a large, dark brown species nearly an inch and a half long and has well developed wings. The Oriental cockroach or black beetle[2] is a nearly wingless, dark brown or black form about an inch long. The Australian

[1] *Periplaneta americana* Linn.
[2] *Periplaneta orientalis* Fabr.

cockroach,[1] frequently brought to our shores by vessels, is a reddish brown form about an inch and a quarter long, easily recognized by the yellow, irregular, oval markings just behind the head. A slender, light green cockroach[2] about an inch long is occasionally introduced with tropical fruits. The smallest and the most pestiferous of all is the croton bug,[3] a light brown, dark marked cockroach only about ¾ of an inch in length.

Habits. The larger American or European cockroaches are frequently somewhat abundant, but the most numerous is the smaller croton bug. These insects find the dampness of water pipes very congenial, and on account of their abundance in such places, they are widely known as water bugs. Roaches, both large and

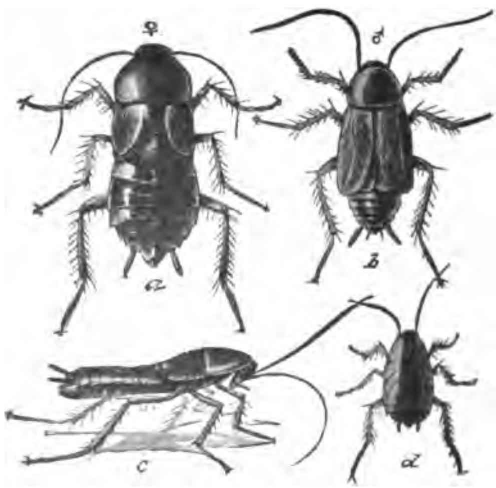

Fig. 20 Oriental cockroach: *a* and *c*, female from above and the side; *b*, male; *d*, a half grown individual; all natural size. (After Marlatt, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

small, feed upon a variety of vegetable and animal matter. The refuse scraps of the sink, the food on the pantry shelves, woolens, leather of shoes, furniture or books, the sizing or paste of cloth-bound books and similar materials are all liable to be gnawed by these almost omnivorous pests. Aside from the actual amount of injury inflicted, the fetid, roachy odor is imparted to infested food stuffs. It is only fair to state that these disgusting pests are known to feed upon that horror of the housewife, the bedbug. There is small choice between the two evils.

[1] Periplaneta australasiae Linn.
[2] Panchlora hyalina Stahl.
[3] Ectobia germanica Linn.

Control measures. Badly infested houses can be cleared of these pests most easily by thorough and perhaps repeated fumigations with hydrocyanic acid gas as described on page 48. Carbon bisulfid, has also been advised as a fumigant. On account of the inflammability of the latter, we would prefer to use in houses the somewhat more poisonous hydrocyanic acid gas. Carbon bisulfid with its heavy fumes is particularly adapted to the destruction of these pests in the holds of vessels.

A still safer method of fumigation consists in burning pyrethrum in infested compartments. It is stated that the vapors of this insecticide are frequently more effective in destroying roaches than the use of the powder itself. The room should be kept closed from six to ten hours. The smoke of burning gunpowder is also very obnoxious and deadly to roaches, particularly the black Eng-

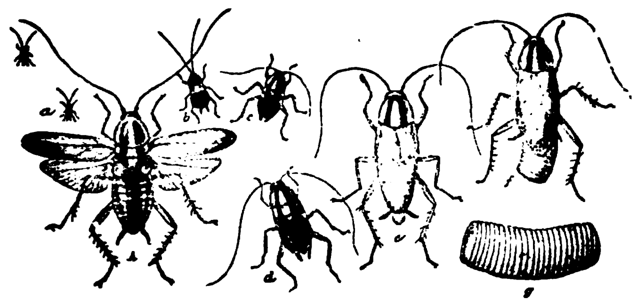

Fig. 21 Croton bug: *a*, *b*, *c*, *d*, successive stages in the development of the young; *e*, adult; *f*, female, with egg case; *g*, egg case enlarged; *h*, adult, with wings spread; all natural size except *g*. (After Riley)

lish roach. The moistened powder should be molded into cones, placed in an empty fireplace and ignited. It is especially valuable in the case of old houses.

There are a number of roach poisons placed upon the market and some of these are undoubtedly very efficacious, particularly if assisted by persistent cleanliness and the eradication of inaccessible haunts, so far as possible. We would further suggest the testing of naphthalene in the flake form, as described on page 27, as a means of at least partially suppressing this pest. The liberal use of Persian insect powder or pyrethrum is also of service in destroying these insects. The paralyzed cockroaches should be swept up and burned.

A relatively simple method, described by Mr Tepper of Australia, is to mix plaster of paris one part, and flour three or four

parts, in a saucer and place the preparation about the haunts of the pests. Near by there should be a saucer containing a little water and made easily accessible to the roaches, by laying a few sticks as bridges up to the rim. The insects eat the mixture, drink the water and soon succumb.

There are several methods of trapping cockroaches, particularly the larger species. A deep vessel partially filled with stale beer or ale can be placed in roach haunts and small sticks adjusted so that the insects can crawl over the edge and to within a short distance from the surface of the liquid. The pests fall into the trap and, being unable to escape, are drowned in large numbers. This method is of comparatively little service with the smaller, more wary croton bug.

Larder beetle[1]

The parent insect, a stout, dark brown beetle with the base of the wing covers mostly yellowish, is frequently rather common about houses in May and June. This insect breeds by preference on animal matter such as ham, bacon, various meats, old cheese, horns, hoofs etc. The very hairy, brown grub is about ½ inch long when full grown.

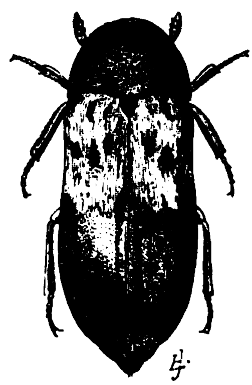

Fig. 22 Larder beetle, seen from above, enlarged. (Original)

Meats and other food stuffs attractive to this insect should be stored in places inaccessible to the beetles. It is said that old cheese can be used very successfully for trapping the parent insects. Cheese or meat infested by the grubs should have the affected part cut away and the surface washed with a very dilute carbolic solution. The packing of meats in tight bagging is of considerable service in preventing attack.

Cheese skipper

The cheese skipper[2] is the young of a small, black, glistening fly about 3/16 of an inch long. The white, cylindric maggots are easily recognized by their peculiar jumping power. This is accomplished by bringing the two ends of the body together and then suddenly

[1] Dermestes lardarius Linn.
[2] Piophila casei Linn.

straightening with a quick muscular action. The maggots of this insect are likely to occur on cheese, particularly that which has been kept for some time, and also upon ham. This species has proved to be a serious pest in some packing houses. It is more or less abundant about cheese factories.

This little pest can be best controlled by storing products likely to be injured, in a dark place. Scrupulous cleanliness is a most efficient preventive. Rubbing daily the bandages and sides of cheese, in hot weather, has been recommended for the purpose of destroying or brushing off eggs. The cheese may be washed with hot whey or with lye, the latter acting as a repellent. Smoked

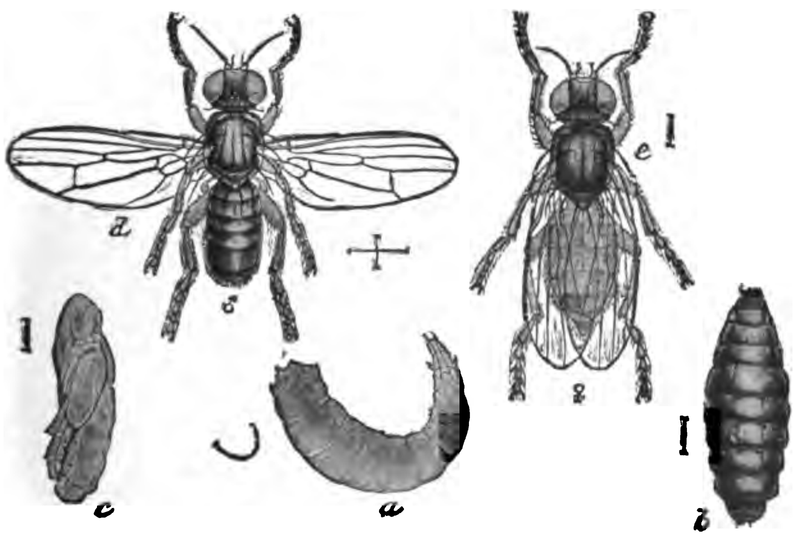

Fig. 23 Cheese skipper: *a*, maggot or larva; *b*, puparium; *c*, pupa; *d*, male fly; *e*, female; all enlarged. (After Howard, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

meats should be put in places inaccessible to the flies. A fine screen, 24 to the inch wire mesh, effectively excludes this little insect.

Cheese or meat infested by skippers is not necessarily ruined, since the injured parts can be cut out and the remainder used as food.

Cereal and seed pests

A number of these insects are likely to occur in houses and, on account of their somewhat similar habits, they are discussed under

a general head. Most of these species are important because of their infesting cereals or cereal preparations of one kind or another.

The Indian meal moth[1] has a wing spread of ¾ of an inch and is easily recognized by the outer two thirds of the wings being reddish brown and with a coppery luster. It is one of the more common of our cereal pests. The whitish, brown-headed caterpillar lives in a large variety of substances, including all cereal preparations and such diverse materials as various nuts, dried fruits, seeds etc. The caterpillar spins a light web to which particles of its food and frass adhere, thus injuring much that is not consumed and affording a ready means of detecting the presence of the pest.

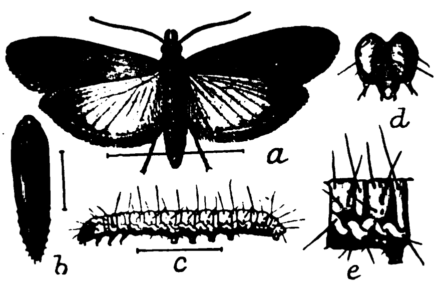

Fig. 24 Indian meal moth: *a*, moth; *b*, pupa; *c*, caterpillar from the side; *d*, head and *e*, first abdominal segment of caterpillar, more enlarged. (After Chittenden, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

The meal snout moth[2] with its different shades of brown and reddish reflections has a wing spread of about ¾ of an inch. The

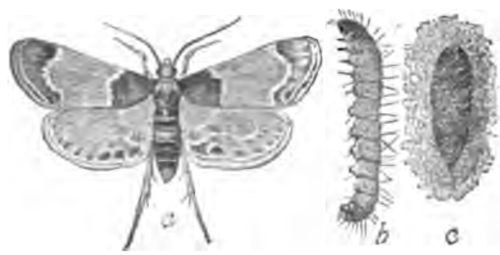

Fig. 25 Meal snout moth: *a*, adult; *b*, larva; *c*, pupa in its cocoon; twice natural size. (After Chittenden, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

whitish caterpillar has a brown head and lives in long silken tubes. It subsists mostly upon cereals though it has been recorded as feeding upon other seeds and dried plants and displaying a preference for clover.

[1] Plodia interpunctella Hubn.
[2] Pyralis farinalis Linn.

The saw-toothed grain beetle[1] is one of the smallest and most persistent of the grain beetles. It is only about 1/10 of an inch long, reddish brown, flattened and easily recognized by the peculiar saw edge along the sides of the thorax. It displays a marked preference for all cereal preparations though it occurs in pre-

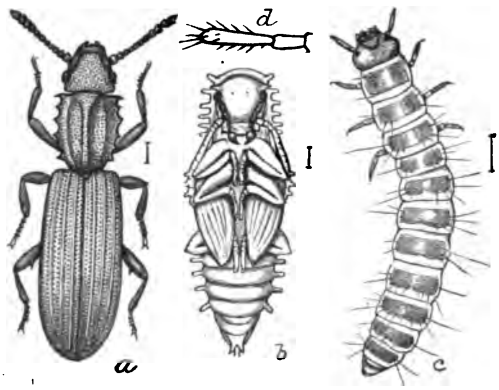

Fig. 26 Saw-toothed grain beetle: *a*, beetle, from above; *b*, pupa, from below; *c*, grub or larva; all enlarged. (After Chittenden, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

served fruits, nuts and seeds and has been recorded as injuring yeast cakes, mace, snuff and even red pepper. This species will breed for extended periods in packages of cereals. The writer had his attention called recently to a case where this beetle multiplied

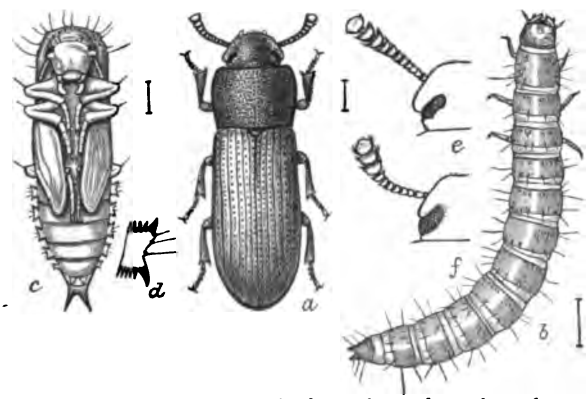

Fig. 27 Confused flour beetle: *a*, beetle from above; *b*, grub or larva, from above; *c*, pupa, from below; all enlarged; *d*, *e*, and *f*, structural details. (After Chittenden, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

by the millions in a brewery, spread therefrom to adjacent houses and caused a great deal of annoyance by getting into everything, not excepting clothing that was worn and bedding in use.

[1] Silvanus surinamensis Linn.

The confused flour beetle[1] is a stout, rust-red beetle about 1/6 of an inch long. It, like the preceding form, has a marked liking for cereal preparations, though it occurs in such diverse products as ginger, cayenne pepper, baking powder, orris root, snuff, slippery elm, peanuts and various seeds. A closely allied form with similar habits, known as the rust-red flour beetle[2] occurs mostly in the Southern States.

The meal worms are rather common pests of meal and the ordinary stable foods. The large, brown or dark brown parent beetles have a length of about ⅝ of an inch and are frequently

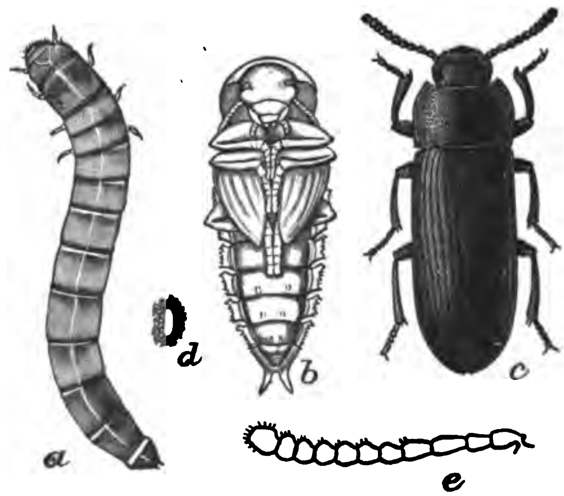

Fig. 28 Meal worm: *a*, larva; *b*, pupa; *c*, female beetle; *d*, egg, with surrounding case; *e*, antenna. *a*, *b*, *c*, *d*, about twice natural size, *e*, more enlarged. (After Chittenden, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

found about houses. There are two closely allied species; the yellow meal worm[3] and the dark meal worm[4]. Both occur under similar conditions and have nearly the same habits. The beetles are frequently attracted to lights. The young or grubs are an inch or more in length, cylindric and yellowish brown. In addition to meal and similar products, they have been found in adulterated black pepper, commercial soda ash, phosphate fertilizers, in the latter instances undoubtedly feeding upon organic matter, possibly cotton seed meal, a well known food of these beetles.

[1] Tribolium confusum Duv.
[2] Tribolium ferrugineum Fabr.
[3] T. molitor Linn.
[4] Tenebrio obscurus Linn.

The cadelle[1] is another inhabitant of grain bins. The beetle is rather stout, shining, dark brown and about ⅜ of an inch long. The peculiar grub or larva, over an inch long, is easily recognized by its flattened appearance and the dark brown plates just behind the head and at the opposite extremity of the body. This species,

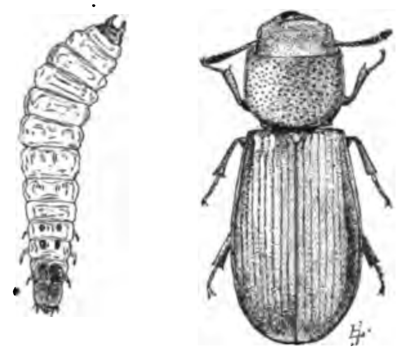

Fig. 29 Cadelle, beetle and larva, from above, enlarged. (Original)

according to Chittenden is predaceous as well as herbivorous. The grub has a faculty for turning up in unexpected places, as for example in milk which had evidently been adulterated with some farinaceous material. It has been found in white hellebore and even in granulated sugar.

The drug store beetle[2] is a rather stout, light brown beetle about ⅛ of an inch long, which attacks a large variety of substances. It occurs in mills, granaries and warehouses, living upon flour, meal, breakfast foods, condiments, roots and herbs and animal sub-

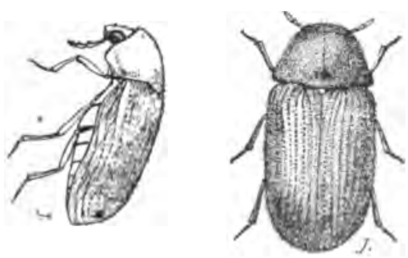

Fig. 30 Drug store beetle, seen from above and the side, enlarged. (Original)

stances. It has even been known to colonize itself in a human skeleton which had been dried with the ligaments left on, and has been recorded as perforating tinfoil and sheet lead. Only two

[1] *Tenebrioides mauritanicus* Linn.
[2] *Sitodrepa panicea* Linn.

months are required to complete the life cycle and in warm dwellings breeding may be continuous throughout the year.

The cigarette beetle[1] is another tiny omnivorous species. The beetle is light brown, stout, slightly hairy and only ⅛ of an inch long. It infests a large variety of food stuffs, including condiments such as cayenne pepper, ginger and rhubarb; drugs of various kinds as ergot and tumeric, and even dried herbarium specimens. It has also been recorded as destructive to silk and plush upholstery. It is best known on account of its work in tobacco,

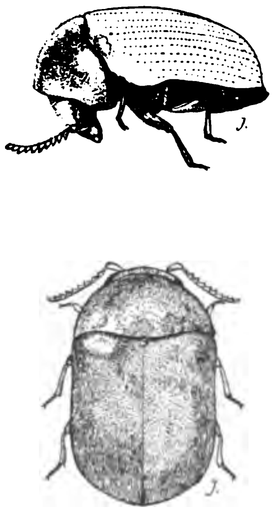

Fig. 31 Cigarette beetle, seen from above and the side, enlarged. (Original)

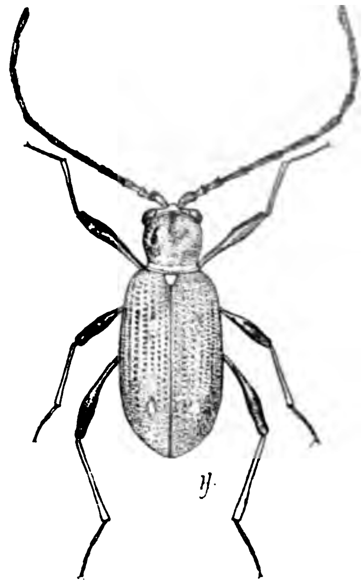

Fig. 32 Spider beetle, seen from above, enlarged. (Original)

cigarettes in packages being frequently perforated by this tiny pest. It occasionally becomes a very serious pest in tobacco warehouses and factories.

Spider beetles. The white marked spider beetle[2] is a small, reddish brown form with four white marks on its wing covers. Its long antennae and legs and subglobular body are suggestive of a spider, hence the common name. This species feeds upon a large variety of dried vegetable and animal substances, such as insect collections, dried plants and herbaria, red pepper, cotton seed,

[1] Lasioderma serricorne Fabr.
[2] Ptinus fur Linn.

refuse wool, and is said to be injurious to furs, clothing, roots, grain, stuffed animals, etc. The brown spider beetle[1] lives with the preceding, has similar habits and differs principally in the absence of the white markings.

The pea weevil[2] and various bean weevils[3] are stout, grayish weevils most easily recognized by their occurring respectively in peas and beans. The original infestation usually takes place in the field, though these insects are capable of breeding for extended periods in the dried seeds of their food plants. The presence of the beetles in a house is an almost infallible indication of infested peas or beans. It is usually more satisfactory to burn a small lot infested by these insects.

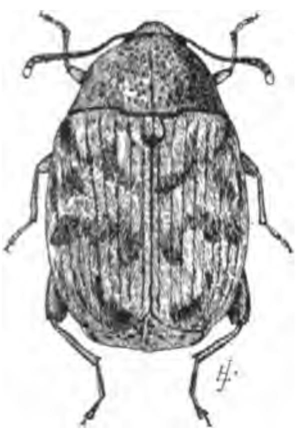

Fig. 33 Bean weevil, seen from above, enlarged. (Original)

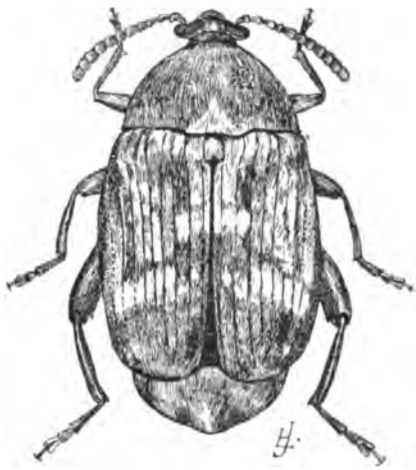

Fig. 34 Pea weevil, seen from above, enlarged. (Original)

Control measures. It is comparatively easy, with the exercise of a moderate degree of care, to avoid serious injury by any of these pests, since they invariably require access to a liberal amount of food for an extended period. Any materials likely to produce numbers of these insects should not be allowed to lie undisturbed and accessible for a series of months. Most of these pests can easily be destroyed by heating the infested material for a period of 4 or 5 hours to about 125 or 150 degrees Fahrenheit. This should be done carefully and time enough given so that the heat will penetrate and destroy all of the insects. Anything infested should be

[1] Ptinus brunneus Duft.
[2] Bruchus pisorum Linn.
[3] B. obtectus Say and others.

promptly cared for either by destroying the entire package or if heating is inadvisable by treating the same with carbon bisulfid.

Fumigation with carbon bisulfid is comparatively easy of execution since it is only necessary to put the material in a tight pail or can, put on the top a spoonful or thereabouts of the insecticide in a shallow saucer or plate, cover the receptacle tightly and allow the whole to stand for preferably 24 or 36 hours. This insecticide may be used on a large scale according to Dr W. E. Hinds, at the rate of 5 pounds to 1000 cubic feet of space, provided the compartments are exceptionally tight and the temperature above 70 degrees F.

FUMIGATION WITH HYDROCYANIC ACID GAS

This is one of the most effective methods of destroying insects in houses, particularly if the infestation is general. It should be remembered at the outset that potassium cyanide, sulfuric acid and their derivative, hydrocyanic acid gas, are among our most active and deadly poisons. They should be handled with extreme care and every precaution taken to avoid an accident, since a slight mistake might result in one or more fatalities.

One ounce of high grade, 98% cyanide of potassium and one fluid ounce of the best commercial sulfuric acid, diluted with two fluid ounces of water, should be used for every 100 cubic feet of space. These amounts should be doubled for poorly constructed houses. The fumigation should last at least 30 minutes and it would be preferable to have it continue three or four hours, or if feasible, all night.

Prior to treatment all fluids, especially liquid or moist foods, should be removed from the house. Arrangements should be made to open the building from the outside after the fumigation is completed. Windows and doors should be sealed as tightly as possible, either by stuffing damp paper in the crevices or pasting strips of paper over cracks. Chimney places, ventilators and other orifices should be closed tightly. The gas is generated by dropping the cyanide of potassium, previously broken into lumps about the size of a walnut and preferably placed in thin bags or wrapped loosely in thin paper, into the requisite amount of diluted acid. The acid should be carefully diluted by pouring it slowly, accompanied by frequent stirring, into the necessary amount of water. This dilution should be slow enough to avoid all danger of this very strong acid splashing and perhaps causing dangerous burns. It will be found

advisable to have one or more jars or generators in each room or hallway, since it is not wise to use more than two pounds of cyanide in a generator. The large, preferably deep, earthenware vessels used as generators should be placed near the middle of the room and on a thick layer of newspapers in order to avoid possible injury from splashing acid. Precautions should be observed, if the building is in contact with others in a row, to see that parties in adjacent dwellings are warned and arrangements made so that the rooms next the treated building will be kept well aired during the fumigation. It is unsafe to attempt to fumigate individual rooms in a house or a building in a row, unless one can be certain that there will be good aeration on all sides of the apartment or building. The deadly character of this gas is shown by the destruction of sparrows resting upon the eaves of a building during fumigation. One should not attempt to fumigate a building or a room alone, because an accident under such conditions is very likely to result fatally. Since hydrocyanic acid gas is lighter than air, operations should commence at the top of the building and proceed successively from floor to floor. Better still, place the requisite amount of the cyanide of potassium in thin bags, suspend each over its generator in such a manner that when a string near the exit is loosened, all will drop into the jars. The poison should not be in a thick paper bag, as the action of the acid may be seriously hindered if not almost prevented.

Under no conditions should any one be allowed to enter the building prior to the completion of the fumigation and its thorough aeration. At least 30 minutes and preferably an hour or more, depending somewhat upon the means of ventilation, should be allowed for this latter process. It is unsafe to enter any recently fumigated building until all the odor of the gas, resembling that of peach kernels, has disappeared. The contents of the fumigating jars should be carefully disposed of together with any remaining cyanide. These substances can either be buried deeply in the soil, or if in a city, may be poured into the sewer.

The following memoranda will doubtless prove of service in practical work.

1 Estimate the cubical contents and the amount of materials for each room.
2 Remove all liquids and moist foods in particular.
3 Seal all exits tightly with strips of paper or by filling crevices.
4 Provide for ventilation from the outside.

5 Weigh out the cyanide and place it in thin bags or do it up loosely in thin paper.
6 Place the generators in the various rooms, each upon a thick layer of newspapers.
7 Dilute the acid carefully and put it in the generators.
8 Distribute the amounts of cyanide to the various rooms.
9 Be certain that everything is all right and nobody in the building or room. *Notify* occupants of adjacent rooms or houses that the fumigation is to be commenced.
10 Drop in the cyanide, preferably from near the exit and close tightly.
11 Adopt suitable precautions to prevent the room or building being entered during the fumigation period.
12 Open the ventilators from the outside.
13 After the building has been thoroughly aerated, remove the generators and take care of their contents together with any excess of cyanide.

INDEX

Education Department Bulletin

Published fortnightly by the University of the State of New York

Entered as second-class matter June 24, 1908, at the Post Office at Albany, N. Y., under the act of July 16, 1894

No. 475 ALBANY, N. Y. JULY 15, 1910

New York State Museum

JOHN M. CLARKE, Director

EPHRAIM PORTER FELT, State Entomologist

Museum Bulletin 141

25th REPORT OF THE STATE ENTOMOLOGIST

ON

INJURIOUS AND OTHER INSECTS

OF THE

STATE OF NEW YORK

1909

New York State Education Department
Science Division, February 23, 1910

Hon. Andrew S. Draper LL.D.
Commissioner of Education

SIR: I have the honor to communicate herewith for publication as a bulletin of the State Museum, the report of the State Entomologist for the fiscal year ending September 30, 1909.

Very respectfully
JOHN M. CLARKE
Director

State of New York
Education Department
COMMISSIONER'S ROOM

Approved for publication this 24th day of February 1910

A. S. Draper

Commissioner of Education

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John M. Clarke, Director
Ephraim Porter Felt, State Entomologist

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25th REPORT OF THE STATE ENTOMOLOGIST 1909

To John M. Clarke, Director of Science Division

I have the honor of presenting herewith my report on the injurious and other insects of the State of New York for the year ending October 15, 1909.

The horticultural world was startled early the present year by the discovery of thousands of young brown tail moth caterpillars in their winter nests on many shipments of nursery stock imported from France. Drastic recommendations were made and promptly adopted by the Commissioner of Agriculture with the result that, so far as known, none of the pests succeeded in establishing themselves. The middle of June was noteworthy on account of the finding of a small colony of nearly full grown caterpillars of this species at Port Chester, N. Y. The thoroughgoing measures adopted in this instance appear to have resulted in extermination.

Fruit tree pests. The most conspicuous injury to fruit the past season was undoubtedly caused by the hordes of plant lice which not only abounded upon apple but were exceedingly numerous on cherry and more or less destructive to plum. The attack on the apple was followed by the trees producing large numbers of small, gnarly fruit, the latter forming 35 to 45 per cent of the total number of fruit in some orchards. The exact records of the injury in the two experimental orchards will be found on a subsequent page. One apple grower estimated the loss at 50 per cent. This phenomenal outbreak coincided with unusually cool weather and was undoubtedly greatly favored by climatic conditions. The cigar case bearer was somewhat abundant in orchards in the west-

ern part of the State, though it was not so numerous as in 1908. The blister mite continued its injuries of last season and in some localities was much more prevalent, this being particularly true of the Hudson valley.

The San José scale continues to be one of the important pests of the horticulturist though progressive fruit growers have little difficulty in controlling it. The general experience with lime-sulfur washes has been exceedingly satisfactory. A number of the commercial preparations of this material have given excellent results. Fruit growers are now beginning to use this wash in a more diluted form as a summer spray for plant lice and fungous diseases.

Codling moth. The codling moth is one of the most important enemies of the fruit grower. A series of practical experiments were carried through the season for the purpose of ascertaining the actual benefit resulting from the application of arsenical poisons, and also the relative efficacy of insecticides applied with a coarse or a fine spray. These experiments were conducted in the orchard of Mr W. H. Hart of Poughkeepsie and that of Mr Edward VanAlstyne at Kinderhook, N. Y. Great pains were taken at the outset to secure an infested orchard with an ample number of trees likely to bear a nearly uniform amount of fruit. Each plot consisted of 42 trees, the fruit from the central six alone being counted. The others were used as barriers to prevent the treatment of one plot reacting upon the trees in another. These experiments involved considerable labor, since three sprayings were given in the case of the orchard at Poughkeepsie. It was furthermore necessary to sort and classify over 100,000 apples in this orchard alone. A reference to the data on a following page shows a most striking difference between the fruit from the sprayed and the unsprayed trees and indicates in no uncertain manner the supreme importance of thorough work.

Small fruits. The unusually severe injury by the grape blossom midge noted in 1908, was continued the past season though the insect may not have been quite so prevalent throughout the grape belt. The acre of early Moore grapes recorded as seriously injured last year was badly damaged the past season. We were fortunate enough in early spring to rear the adult, a fragile midge which has hitherto escaped notice although the blighted blossom buds have been common for several years. Owing to the delay in issuing the report for 1908 it was possible to give, in that publication, a full account of the pest.

The grape root worm, though generally prevalent in the Chautauqua region, has not caused much alarm. This is due in part to a more thorough understanding of the insect and methods of controlling it, and also to better cultivation and fertilization. The latter are important factors in producing vines capable of withstanding injury.

Shade tree pests. The protection of our shade trees from the ravages of insect pests has continued, as it most assuredly should, to receive much attention. It is gratifying to record that the general public is displaying a most commendable interest in this phase of economic entomology. There have been numerous demands for information in regard to these pests and methods of controlling them. The supplying of such has been an important part of the office work.

The elm leaf beetle has been somewhat prevalent in the Hudson and Mohawk valleys. It caused extensive injury for the first time in the city of Amsterdam and was quite destructive at Schenectady and also at Sandy Hill. There was general though not very severe injury in both Albany and Troy, while judging from reports this pest has been exceedingly destructive to elms on Long Island.

The spruce gall aphid, noticed in the preceding report, has continued abundant and rather injurious in widely separated portions of the State. It is a species which should be watched closely, since it is capable of causing severe damage, by destroying the terminal twigs and thus stunting the growth.

The sugar maple borer continues to be a serious enemy of maples. It was particularly abundant the past summer at Fulton, N. Y. A number of trees in that village were badly affected and a few were dying as a result of the recent work of this pernicious borer.

Forest insects. The ravages of forest insects are increasing in severity with the lapse of time. Our forest trees have suffered greatly in recent years from outbreaks by leaf-feeding caterpillars. The snow-white linden moth has been one of the chief offenders. The past season was marked by extensive depredations by this pest. The flight of hosts of white moths about city and village lights, so generally noticed in 1908 was observed the past season.

The small, modest, grayish and olive-brown moths of the spruce bud worm attracted unusual notice in midsummer on account of their prevalence at street lights in a number of widely separated cities. These flights, judging from reports received, have been preceded by serious injuries to spruce trees in the Adirondacks.

The hickory bark borer, a most pernicious enemy of hickories, has been very injurious to the magnificent trees of Prospect Park, Brooklyn. Injuries by this pest have also been reported from the central portion of the State. This nefarious pest has in recent years destroyed thousands of valuable trees in this State. Its destructive potentialities amply justify the prompt destruction of infested trees.

Gipsy and brown tail moths. The appearance of the latter species in this State has already been mentioned and must be regarded as but the precursor of similar visitations. This insect has not, to our knowledge, become established west of the Connecticut valley, and it is to be hoped that the repressive measures, prosecuted jointly by the state of Massachusetts and the federal government, will result in keeping this destructive form at a distance for some years to come.

The finding of numerous winter nests of the brown tail moth upon imported French stock last winter resulted in our conducting a series of experiments for the purpose of determining the efficiency of hydrocyanic acid gas as an agent in the destruction of the caterpillars. Though this most deadly gas has given excellent results with other species, it proved of no service in killing brown tail moth caterpillars within their nests, and could not be relied upon to destroy free caterpillars in a dormant condition at any reasonable strength and without an unduly prolonged exposure. The details of these experiments, showing the unreliability of this gas, are given on a following page. On the other hand, dipping the caterpillars in a miscible oil was invariably followed by death.

There is still no authentic record of the gipsy moth having become established in New York State. The pest has not made its way nearer than the outlying small colonies known to exist at Springfield and Greenfield, Mass. and the more recent infestation at Wallingford, Conn. The Entomologist has sent out a number of warning placards to places where these insects would be most likely to become established and as yet nothing suspicious has been discovered.

Miscellaneous. The large, olive-colored form known as Say's blister beetle was unusually abundant in the vicinity of Albany and occasioned some anxiety lest it prove a serious pest. There was a restricted outbreak of the army worm at Oakdale. Conditions were evidently rather favorable for more extended mischief by this insect, since the writer found the caterpillars numerous at Port

Chester though not very evident on account of the large amount of provender upon which they could subsist.

House fly. This insect, with its acknowledged potentiality for evil, is one of the most important of our injurious species. The present great interest in the house fly and methods for its control led to the devising of a vivarium or special house for the purpose of testing the behavior of this insect in relation to light and in particular to ascertain whether darkness or partial darkness could not be used as a barrier to keep this ubiquitous form from breeding materials of various kinds. The house was a light-proof structure with partitions arranged in about the same way as those in the photographer's dark room, and flies were given a free opportunity to enter as far as they would with a constantly decreasing illumination and deposit eggs upon moist horse manure. The details of the experiments, given on a following page, show that this insect will not invade moderately dark places for the purpose of depositing its eggs. It should be comparatively easy and very practical to store all such materials in dark or nearly dark places.

Gall midges. The work upon this group has been pushed as rapidly as possible consistent with the discharge of other duties. We have been able to make material additions to our knowledge of the biology of this group. This was particularly marked in the case of Sackenomyia, originally described from a female taken on the wing and now represented in addition by two reared species, of which both sexes, larvae and galls are known. The life histories of a number of species of Caryomyia, forms responsible for the peculiar and varied hickory leaf midge galls, have been worked out. Likewise, a number of species of Cincticornia, a genus confined to oak, have been reared and some exceedingly gratifying data obtained. This by no means exhausts possibilities with this group, since material has come in so rapidly in recent months that it has been practically impossible to classify it adequately and at the same time collect or rear additional forms. Over 50 species have been reared during the year, most of them new and making a total in the collections of probably over 800 species, about 350 having been reared. This large number of specimens, in some instances species are represented by a hundred midges, is practically classified and requires only a relatively small amount of descriptive and collative work before being made available to the public.

Special acknowledgments in this connection are due Miss Cora H. Clarke of Boston, Mass. who has collected and forwarded to

us large series of galls from which we were able to rear a number of previously unknown species. The care of this material devolved largely upon Assistant D. B. Young, who has met with exceptional success in rearing the flies. Miss Fanny T. Hartman has assisted in caring for the biological material and has made excellent microscopical mounts of many of these extremely delicate midges.

Publications. Many brief, popular accounts dealing with injurious insects have been prepared by the Entomologist for the agricultural and local press and a few notices of more than general interest have been disseminated as press bulletins or through the agency of the Associated Press. A comprehensive popular bulletin on the *Control of Household Insects,* made advisable by the recent great advances in our knowledge of the relation of insects to the dissemination of disease, was issued in May and is now, due to the great demand for such information, practically out of print. The report for last year, owing to delays incident to publication, was not issued till the last of the present year. A popular account summarizing one phase of our studies of gall midges and entitled: "Gall Midges of the Goldenrod," appeared in the *Ottawa Naturalist* for February. Biological data and brief descriptions of nearly 50 reared species of Cecidomyiidae were published in the issue of the *Journal of Economic Entomology* for August.

Collections. The additions to the collections have not been very extensive, since the amount of material already at hand demands the expenditure of much time before it can be properly classified. Particularly gratifying additions have been made by rearing large series of Caryomyia, Cincticornia and Sackenomyia, the biology of these genera being previously unknown. There have been valuable contributions of biological material, mostly insect galls, through the generosity of Miss Cora H. Clarke of Boston, Mass.

The general work on the arrangement and classification of the collection has been pushed as rapidly as possible. Mr D. B. Young has identfied practically all our species of Bombylidae, has done considerable work upon the Empididae and made substantial progress in classifying the Sapromyzidae, the Tabanidae and the Sciomyzidae. Mr Young is also responsible in large measure for the preparation of the list of insect types in the New York State collection given on a following page. Much of Miss Hartman's time has been devoted to the care of breeding material, to mounting and

labeling, to interpolating specimens, particularly Microlepidoptera in the general collections, and to bibliographic work.

Several greatly enlarged models representing injurious insects or portions of such forms have added very much to the educational value of the entomologic exhibit. A list of these models is given on a succeeding page. This is only the beginning of what should be done along this line, since if one may judge from the work of other museums, the practical value of the exhibit collections has been greatly enhanced by accurate and tastefully executed models of important species. It is to be hoped that provision can be made shortly for the continuance of this work along comprehensive lines.

Office matters. The general work of the office has progressed smoothly, the Assistant State Entomologist being responsible for correspondence and other matters during the absence of the Entomologist. Both Mr Young and Miss Hartman devoted much time to the experiments with larvae of the brown tail moth noted on another page. Numerous specimens have been received for identification and many inquiries made concerning injurious forms. 1851 letters, 614 postals, 208 circulars, 2597 packages were sent through the mails and 83 packages were shipped by express.

Nursery certificates. On the request of the State Commissioner of Agriculture, as in previous years, nursery certificates issued by his office and destined to points in the state of Virginia, were indorsed by the Entomologist. The following is a list of the firms to whom these nursery certificates were issued during the past year: Greens Nursery Co. and the Pan-American Nurseries, both of Rochester; Jacob Uhl, Maloney Bros. & Wells, Sherrins Wholesale Nurseries, all of Dansville and F. E. Schifferli of Fredonia.

General. As in past years, the work of this office has been greatly facilitated by identifications of certain species through the courtesy of Dr L. O. Howard, Chief of the Bureau of Entomology, United States Department of Agriculture and his associates. Several correspondents have been of material service in securing valuable specimens of one kind or another and as heretofore there has been a most helpful cooperation on the part of all interested in the work of this office.

Respectfully submitted

EPHRAIM PORTER FELT

State Entomologist

Office of the State Entomologist, October 15, 1909

INJURIOUS INSECTS

Typhoid or house fly

Musca domestica Linn.

An attempt was made the past season to obtain accurate data respecting this insect's behavior toward light. The principal object of the experiment was to determine the possibility of storing manure and other substances in which this pest breeds, in dark or nearly dark cellars or compartments.

Outline of conditions. A fly vivarium [pl. 1] was located in the writer's back yard (a typical village lot) at Nassau, Rensselaer co., N. Y. This building was a nearly light-proof structure 6 feet by 10 feet in outside dimensions and with a hight of 6 feet 4 inches in front and 5 feet 6 inches in the back. To facilitate the location of materials etc., the spaces between the joists were numbered consecutively, beginning at the door on the north wall and running around and including in the enumeration the spaces of the partitions as well as the outside wall [*see* pl. 2]. A light-proof window (18 x 18 in.) was made in the south wall near the southwest corner (at station 16) and another in the west wall (at station 13). Light-proof partitions, arranged somewhat like those in a photographer's dark room divided the interior [*see* pl. 2] in such a manner that there was a constant decrease in the light as one progressed from the door back through the partitions and around to the darkest corner near the middle of the south end, station 12. Ventilators were provided in the roof at A and B [*see* pl. 2]. There is in the southeast corner at station 23, a small closet 21 inches deep and 3 feet above the ground. The interior of the building was painted a dull black the latter part of April. The door located at the northwest corner is 26½ inches wide and 71¼ inches high. This door was allowed to remain open throughout the season and the entrance of animals or children prevented by the use of a coarsely screened (½ inch mesh) door having an interior clear space of 23 by 67 inches. The building was so situated that August 24 at 8 a. m. rays of the sun reached back to the base of the corner of station 8 and a little later in the day would extend to the base of the pail at station 6. There was sufficient illumination under these conditions at station 18 so that one experienced little difficulty in discerning objects located there. Mackerel kits containing horse manure thoroughly sterilized by steam were located at stations 6, 12, 18 and 23. In addition, sheets of a dull black paper, specially treated through the courtesy of the O. & W. Thum

Co. of Grand Rapids, Mich., with the preparation so familiar on tanglefoot fly paper, were tacked up at stations 2, 4, 6, 12, 14, 18 and 22 about 5 feet from the ground. The vivarium was located about 20 feet from one barn where a horse was kept, the manure from the animal being thrown outdoors. There was another barn where at least two animals were kept throughout the summer about 40 feet away to the southwest and another barn about 50 feet due east. This latter had been occupied in previous years by six to eight horses, and when the vivarium was constructed it was expected that an equal number of animals would be kept in the building throughout the summer. Owing to a change of plans but one horse was kept in this barn, and as a partial result of this change there have been considerably fewer flies than in previous years. Furthermore, the excessively cool weather continuing well into June greatly delayed the appearance of the house fly in numbers. Relatively cool weather continuing throughout the summer has also served to prevent rapid breeding. This combination of causes has resulted in house flies being much scarcer than usual.

Experiments. House flies were becoming somewhat abundant June 23d and operations were commenced by placing mackerel kits nearly filled with sterilized horse manure at stations [*see* numbers on plate] 6, 12, 18 and 23. At the latter station there was a second mackerel kit or check pail containing ordinary horse manure. Practically no flies were observed about the vivarium June 23d and the same was true the morning of the 24th. An examination Saturday afternoon the 26th gave negative results, since there were no evidences of flies in the house, aside from a possible specimen or two just within the screen door. On the afternoon of June 29 a fly was seen at station 22 and several at station 6. There were no signs of house flies at stations 8, 18 or 12. July 17, 5 or 6 house flies were seen about the door. August 3 they were rather numerous in and about the vivarium. On this date a second pail of sterilized horse manure was placed at each of the stations just mentioned and in addition, a pail about ⅔ full of miscellaneous swill covered with 2 inches of horse manure was set just outside the door in the hopes of attracting more flies. The records will now be given by stations, beginning with the pail outdoors.

Pail outdoors containing swill and manure. August 23 this pail was found to be filled by recent rains and contained several Muscid larvae. September 11th this pail, though well shaded by squash vine leaves, contained 12 large dipterous larvae, probably *Musca domestica* and a rat-tail syrphid larva, probably *Eristalis tenax* Linn. We were unable to rear these larvae to maturity.

Station 23. June 29 numerous Borborids, Limosina sp., were observed in the mackerel kit containing untreated horse manure, undoubtedly issuing from this and spreading from the check to the adjacent sterilized manure. July 23d the surface of the manure was rather dry and both pails were in nearly the same mechanical condition. The manure was watered July 10th and the 13th, only a few flies being observed on these dates. July 17 the conditions at station 23 were nearly the same as at station 6 though small flies were not so numerous and on the 21st flies were much less abundant than at station 6. August 23 this pail contained numerous small flies and larvae though none of Musca domestica. The manure was well rotted and wet. The check pail was practically in the same condition. September 11 there were numerous Sciaras on the surface of the manure and a few small Cecidomyiid larvae; the manure was quite wet, rather well rotted and the pail only about half full. The check was in nearly the same condition. September 26 Psychodids were rather numerous.

The new pail contained young mushrooms August 23 and there were a few small flies on the surface of the manure. September 11 there were several Muscid larvae, some Sciara larvae and a few small Cecidomyiid larvae in the manure. Sciara adults were numerous. The pail contents were nearly saturated and but slightly rotted. September 27 Psychoda alternata adults were rather abundant.

Station 6. One house fly was observed on the manure June 29 and several nearly full grown maggots were found some 4 inches below the surface July 8. The contents of the pail were wet July 10th and 13th and numerous small flies and 5 or 6 house flies were observed on or about the manure on July 17th, shortly after some swill consisting of orange peelings, vegetable parings, biscuit etc. had been placed near by. July 21 numerous specimens of Drosophila ampelophila were seen flying in the vicinity of the manure, alighting upon the swill, crawling upon adjacent walls and hovering in the upper section of this part of the house. They also spread somewhat to station 8 but none were observed in the vicinity of stations 18 and 12. These insects were undoubtedly attracted in large measure by the swill, since they were much less numerous at station 23 though somewhat abundant. August 3 house flies were entering freely, going back to station 6 and spreading a little on one side to station 8. The manure was inhabited by many

small dipterous larvae, probably Drosophila; the contents of the pail were quite moist. August 23 there were a number of small flies and other larvae. There were numerous small flies (Borborids, Limosina sp. and a few Sciaras), some pupae and several Staphylinids in and about the pail September 11. There were also many Psychoda alternata Say, about the pail September 25.

The new pail placed in the house August 3 contained young mushrooms the 23d. There were a few small flies on the surface. September 11 the contents were saturated, slightly rotted and were frequented by a few small flies. A Musca puparium was also found. There were some small mushrooms. September 27 numerous Psychoda alternata Say, were observed in and about the pail.

Station 18. June 29 there were no signs of flies at this station. July 8 there was no evidence of maggots being present though the pail was more moist than those at stations 6 and 23. July 17 there was much fungus on the manure though no flies were observed, not even Sciaras. The same was true July 21 and 25. August 3 there were a very few small flies on the margin of the pail but no evidence of larvae. August 23 there were a few small flies, probably Limosina and Sciara and several clusters of larvae, the latter being much less abundant than at stations 6 and 23. September 11 a few small flies and dipterous larvae were seen. The larvae were probably those of Sciara and Limosina. Psychoda alternata was reared from this pail, also a species of Scatopse. September 27 Psychoda alternata was rather abundant about the pail.

The new pail placed in the house August 3 was frequented by only a few small flies on the 23d. There was no evidence of larvae being present. September 11 only a few small flies, mostly Sciara and Limosina were seen. There were a few mushrooms in the pail. September 27 Psychoda was rather abundant.

Station 12. June 29 there were no signs of flies and the same was true July 8 though the pail was fully as moist as the others. July 17 conditions were practically the same as at station 18 though with perhaps less life, only a few mites being observed. Fungus was rather abundant on the manure. July 21 and 25 no flies were observed. August 3 neither flies nor larvae could be found. August 23 there were a few small flies

and several groups of larvae. The presence of these insects is possibly explained by a small amount of light being admitted through a recent mousehole made from near station 6. September 11 there were a few small flies and dipterous larvae together with two Glischrochilus quadriguttatus Fabr. September 27 Psychoda alternata was somewhat numerous about the pail.

The new pail placed in the house August 3 contained one or two small flies the 23d. September 11 there were a few small flies and several dipterous larvae from which a Drosophila was subsequently reared. September 27 Psychoda alternata was somewhat abundant.

Summary. A careful scrutiny of the above records will show that while Musca domestica and its larvae were found at both stations 23 and 6 there were none to be seen at stations 18 and 12. Furthermore, the house fly was much more abundant in the pail just outside the house though the latter was in a somewhat sunny place and owing to frequent rains and rather low temperature, full of water practically all the time. In this connection it is interesting to note that this pail with its saturated contents was much more attractive than similar pails within containing manure in a moist or rather wet condition. It may be worthy of note in passing, that the one place where the writer found house flies literally swarming during the past summer was in a barn cellar where hogs were running over thoroughly saturated excrement. There was a marked difference in the number of small flies occurring in the pail at station 18 as compared with the number found at station 6 and it is probable that there would have been an almost equally great difference between the abundance of the dipterous fauna at station 12, the darkest point of the house and station 18, which at midday had an illumination which might be characterized as twilight, had it not been for the mouse burrows admitting light.

The above data, while not so conclusive as could be desired, shows that the house or typhoid fly does not breed freely in darkness. This pest exhibits a decided preference for sloppy filth in light places. It is practical and thoroughly in accord with the best agricultural practice to either draw out and spread manure at frequent intervals, or to store it in cellars or sheds. The relatively cheap cement underpinning makes it comparatively easy to construct dark cellars, places where

manure or other fly-breeding material can be kept without producing swarms of flies. These measures, while particularly adapted to the farm will also prove of service in villages and cities.

Brown tail moth

Euproctis chrysorrhoea Linn.

This insect, to the consternation of our horticulturists and nurserymen, was brought into New York State by the thousands with importations of French seedlings in January 1909. Thanks to the radical measures adopted by the Commissioner of Agriculture on the recommendation of the Entomologist and his associates at Ithaca and Geneva, this pest, so far as can be ascertained, has not become established as a result of this recent introduction. The emergency existing in consequence of this wholesale importation made it extremely desirable to find some treatment aside from the removal and burning of the winter nests and their inhabitants, which could be relied upon to destroy any caterpillars escaping the inspector's eye. The experiments detailed on following pages show in a striking manner the futility of depending upon any method of fumigation with hydrocyanic acid gas for the purpose of destroying active caterpillars, not to mention the more resistant dormant larvae.

Another infestation. The danger of this voracious leaf eater becoming established in New York was strikingly emphasized June 16 by nursery inspector T. F. Niles of the State Department of Agriculture finding a small colony of nearly full grown larvae on the estate of W. W. Cook at Port Chester, N. Y. A personal examination by the writer, in company with Messrs Atwood, Niles and other representatives of the Department of Agriculture on Saturday, June 19, resulted in finding about six more full grown larvae, making a total of 16 in all. The infestation, so far as careful inspection showed at that time, was limited to seven clumps of Crataegus located in the northwest corner of a large cultivated field which had been planted extensively with ornamental shrubs and trees. The caterpillars were undoubtedly brought into the State with the Crataegi which had been purchased by Mr Cook from the Arnold Arboretum. Subsequent inspections on the 20th and 21st resulted in finding no more larvae. It was decided, owing to the dangerous nature of the pest, that drastic measures were by all means advisable. All herbaceous vegetation within 100

feet of the thorn trees where larvae were found was destroyed by means of a cyclone burner (a cyclone nozzle burning crude oil) and the bare soil repeatedly burned over in this manner, except that between the young trees the surface soil was removed prior to the treatment. Before this operation the Crataegi and other trees within the infested area were carefully inspected, banded with tree tanglefoot and then repeatedly sprayed with a petroleum whale oil soap solution for the purpose of destroying any caterpillars which might possibly have escaped observation. The remains of a winter nest of a brown tail moth was discovered on the other side of the estate and similar measures pursued, except that the surface soil was removed prior to the burning. This latter work was done so thoroughly as to destroy grass roots in firm vigorous sod. The insecticide was strong enough to cause quite a little dropping of the foliage though the trees were not materially injured.

These precautions were supplemented by the operations of trap lanterns near the two centers of infestation from the latter part of June to July 16, for the purpose of attracting thereto and capturing any individual which might possibly have escaped the treatment described above. Nothing suspicious came to the lights or was observed in the vicinity, despite repeated examinations made of trees, poles and buildings in the vicinity. The captures with the trap lantern in the center of the larger burned area were remarkably scarce, especially for the first few days after the burning.

A general survey of the vicinity September 21st resulted in finding nothing suspicious and showed further that none of the trees in the treated area had been seriously affected.

Destructiveness. The caterpillars of the brown tail moth are exceedingly voracious, feeding by preference on the foliage of apple, pear, plum, wild cherry and white oak, though they thrive on both soft and hard maples and also elm. These pests have been exceedingly abundant in recent years in the Middlesex fells and other extensive wooded areas north or northwest of Boston, Mass., defoliating large tracts of white oaks. Numerous apple and pear trees throughout the infested region have been killed or are in a dying condition and bear striking testimony to the voracity of this caterpillar. Furthermore, the irritating hairs blowing from the nests or cocoons are constantly causing serious discomfort on account of the severe irritation produced. This insect, in association with the

gipsy moth caterpillar, has materially reduced real estate values in some of the worst infested sections.

Watch for the pest. The material injuries outlined above emphasize the necessity of keeping a close watch for the appearance of this insect, to be followed by prompt repressive measures if we would avoid extended losses. The Entomologist, in past years, has sent out a warning placard illustrating this insect and the gipsy moth in colors and giving the salient characteristics of both species. These placards may still be obtained upon application. A general publication [N. Y. State Mus. Bul. 103] has also been prepared and will be sent to interested parties.

Salient characters. The moths are snow-white, brown tailed insects with a wing spread of 1¼ to 1½ inches. They are abroad in early July, fly readily and may be carried considerable distances by favorable winds.

The eggs are deposited in midsummer on the under side of leaves, in patches covered by brownish hairs or scales. The young caterpillars appear in August and feed for the most part in the tops of trees. They occur by preference on wild cherry, pear, apple, maple, elm and white oak, constructing a very characteristic, close, firm web nest [pl. 22] differing greatly from the loose, open nests inclosing many leaves, of the fall webworms and easily distinguished from those of the common tent caterpillar because they are at the tips of small limbs and not in the crotches.

The brown tail moth caterpillars winter in firm nests inclosing a few leaves and invariably at the tips of twigs. Consequently, winter is one of the most favorable seasons for the detection of this pest. We would urge every one residing in a locality liable to infestation, to keep a close watch for the presence of these characteristic winter nests.

The nearly full grown brown tail moth caterpillar, found only in late May and early June, is about an inch long, a bright tawny or orange-brown color, with a conspicuous row of white spots on either side and two bright red spots on the back near the posterior extremity.

Experimental work. The following experiments with hydrocyanic acid gas were conducted during the winter and early spring, in an effort to find a reliable method of freeing nursery stock from any caterpillars which might escape the inspector's eye. The larvae used for experimental purposes were obtained

from nests taken from imported French stock and were allowed to remain in a warm office at least over night. The experiments detailed in series 1 to 4 inclusive, were performed in ordinary two-quart fruit jars, healthy caterpillars being removed from the nests and placed on blotting paper a short distance from the necessarily small generators. The small scale upon which the experiments were conducted rendered it possible to make a large series of tests and in a relatively short time. Special care was taken in the experiments detailed in series 2, to prevent the exposure of the jars to direct sunlight, since that undoubtedly accentuates the action of hydrocyanic acid gas. The records in series 4 give the results of parallel tests between glass jars exposed to ordinary light and those kept in darkness. The caterpillars in this last series had been in a warm room for over 24 hours, having been shipped from Rochester January 26 and arriving in Albany the morning of the 27th.

The experiments in series 5 are particularly instructive, since they were performed in a zinc lined cubical box 3 by 3 by 3 feet and containing 27 cubic feet. The overlapping edges were carefully soldered and the removable side, its face being lined with zinc, was held in place by a series of 8 bolts with thumb nuts. An air-tight joint was secured by clamping the cover down on to a strip of rubber ¼ inch thick and 1 inch wide. Two drams of cyanide of potassium for each charge corresponded very closely to 1 ounce for 100 cubic feet of space, the slight excess probably being offset by the ¼ inch rubber strip adding slightly to the capacity of the box. Ten larvae were placed in each of several mica lamp chimneys suspended horizontally at different hights or placed in different portions of the box, the open ends being covered by coarse cheese cloth held in place by elastic bands. The larvae used in experiments 1 to 7 of this series were received early in February and kept in a cool place till needed. Practically none had begun to crawl and they were therefore in a hibernating condition. Those employed in experiments 8 to 16 were on importations received in March and had begun to leave the nests in considerable numbers.

A number of active caterpillars were placed in an ice box in early April and kept at a low temperature for six days. These, though apparently in a hibernating condition, proved no more resistant to hydrocyanic acid gas fumes than active larvae.

Experiments with brown tail moth caterpillars

Series 1, January 15, 1909

Number of experiment	Grains cyanide	Hours exposed	Number of larvae	Observations at close of fumigation	Later observations
4	1	3	4	All dead	Same, 18th, 20th
5	1	3	4	"	" " "
8	1	1	4	Apparently dead	1 alive on 18th and 20th
9	1	21	4	Dead	Same, 18th and 20th
1	¼[1]	1	4	2 alive	4 alive 18th and 20th
2	¼	21	5	Dead	Same, 18th, 20th
3	¼	3	4	"	" " "
10	¼	3	4 & nest	3 alive 18th 2, 20th	Alive in nest
11	¼	6	4 "	Exposed caterpillars dead	All exposed caterpillars dead 18th, 20th most in the nest dead
6	⅛	3	4	Apparently dead	Apparently dead 16th, 1 alive the 18th, all dead the 20th
7	⅛	21	4	All dead	Same, 18th, 20th
12	⅛	3	4 & nest	2 alive	2 alive the 20th, those in nest alive
13	⅛	6	4 "	Exposed caterpillars dead	Same, 18th, caterpillars in nest alive
Series 2, January 20, 1909					
1	¼	6	8	Dead	Same, the 21st
3	¼	6	8	"	" " "
6	¼	5	8	"	" " "
7	¼	5	8	"	" " "
8	¼	4	8	"	" " "
11	¼	4	8	"	" " "
12	¼	3	8	"	" " "
13	¼	3	8	"	" " "
2	¼	6	8	"	" " "
4	¼	6	8	"	" " "
5	¼	5	8	"	" " "
9	¼	5	8	"	" " "
10	¼	21	8	"	" " "
14	¼	4	8	"	" " "
15	¼	4	8	"	" " "
16	¼	21	8	"	" " "
17	¼	3	8	"	" " "
18	¼	3	8	Apparently dead	1 alive 21st, 22d
Series 3, January 21, 1909					
1	¼	1	8	Dead	Same, the 22d
2	¼	1	8	"	" " "
5	¼	2	8	"	" " "
6	¼	2	8	"	" " "
9	¼	3	8	"	" " "
10	¼	4	8	"	" " "
3	¼	1	8	Alive	Same, 22d, 23d
4	¼	1	8	"	" " "
7	¼	2	8	Apparently dead	Several alive the 23d, small piece of web present
8	⅛	2	8	Dead	Same, the 22d
11	⅛	3	8	Apparently dead	Several alive the 23d, pieces of nest present
12	⅛	4	8	Dead	Same, the 23d
Series 4, January 28, 1909					
1	¼	3	10	All apparently dead	All dead the 3[illegible]
2	¼	3	10	" " "	" " "
3	¼	3	10	" " "	" " "
4	¼	2	10	" " "	" " "
5	¼	3	10	" " "	" " "
6	¼	3	10	" " "	" " "

[1] ¼ grain equals approximately 1 ounce to 100 cubic feet of space.

Experiments with brown tail moth caterpillars (*continued*)

Series 5, March 2, 1909

No. of experiment	No. of cage	Hight of cage in inches	Drams cyanide	Hours exposed	No. of larvae	Observations at end of fumigation	Later observations
1..........	1	26	2[1]	2	10	1 alive.......	2 alive March 3, 3 alive March 5
1..........	2	20	2	2	10	2 "	4 alive March 3, 3 alive March 5
1..........	3	13	2	2	10	1 "	7 alive March 3, 5 alive March 5
1..........	4	6	2	2	10	1 "	7 alive March 3, 4 alive March 5
1..........	5	1	2	2	10	1 "	3 alive March 5
1..........	6	0[2]	2	2	10	6 "	5 alive March 5
1..........	7	0[3]	2	2	10	1 "	2 alive March 3, 3 alive March 5
2..........	1	26	2	2	10	1 "	2 alive March 3, 1 alive March 5
2..........	2	20	2	2	10	4 "	4 alive March 5
2..........	3	13	2	2	10	1 "	2 " " 5
2..........	4	6	2	2	10	1 "	2 " " 5
2..........	5	1	2	2	10	Apparently all dead.......	1 " " 5
2..........	6	0[4]	2	2	10	Apparently none alive..	1 " " 5
3..........	1	25	2	3	10	All apparently dead.......	1 alive March 4, 5
3..........	2	13	2	3	10	All apparently dead.......	All dead March 5
3..........	3	1	2	3	10	All apparently dead.......	1 alive March 4, 2 alive March 5
3..........	4	0[5]	2	3	10	All apparently dead.......	All dead March 5

[1] Two drams equals 1 ounce to 100 cubic feet of space.
[2] Cage with end against side of box.
[3] Standing on end on the bottom of fumigation box.
[4] Cage laid on bottom with both ends unobstructed.
[5] Cage lying on bottom of box but in the far corner.

Experiment 4, March 3, is a duplicate of number 3. At the close of fumigation the larvae were apparently all dead, this finding being confirmed by observations March 5.

Experiment 5, March 4, is practically a duplicate of experiments 3 and 4, except that the exposure was for but 1 hour and 4 drams of cyanide were used instead of 2 drams. At the close of the fumigation a few larvae in cages 1 to 3 were apparently alive, while those in number 4 appeared to be dead. March 5 cage 1 had 5; cage 2, 5; cage 3, 7 and cage 4, 9 living larvae. March 6 there were 4 living larvae in cage 1; 4 in cage 2; 6 in cage 3 and 9 in cage 4.

Experiment 6, March 4, was a duplicate of experiment 5, except that the exposure was continued for 2 hours. All the larvae were apparently dead at the end of the fumigation period. March 5 there was 1 living larvae in cage 1; 5 in cage

3 and apparently none in cages 2 and 4. March 6 there were 2 living larvae in cage 1; 8 in cage 3 and 1 in cage 2, all being dead in cage 4.

Experiment 7, March 4, was a duplicate of experiment 6. March 5 there was 1 living larva in cage 1 and all appeared dead in cages 2 to 4. March 6 there was 1 living larva each, in cages 1, 2 and 3, while all were dead in cage 4.

Experiment 8,[1] tried March 29, the exposure being 3 hours and the amount of cyanide 4 drams. The caterpillars were all apparently dead at the end of the fumigation, the finding being confirmed by observations March 30th.

Experiment 9, March 28, the exposure being 2 hours and 4 drams of cyanide being employed. The caterpillars appeared to be dead at the end of the fumigation March 30th. One was barely alive in cage 3 and all were dead April 1st.

Experiment 10, March 30, with an exposure of but 2 hours and 2 drams of cyanide. The larvae were apparently all dead at the conclusion of the experiment. March 31st there was 1 alive in cage 1; 5 alive in cage 2 and 2 alive in cage 3. April 1, 1 was alive in each of cages 1 and 2 and 2 in cage 2. April 2, 1 was alive in each of cages 1 and 2, the others being dead.

Experiment 11, March 30, with an exposure of 1 hour and 2 drams of cyanide. All the caterpillars were apparently dead at the close of fumigation. March 31 all were alive in cages 1 and 2 and but 3 dead in cage 3. April 1, 8 were alive in cage 1 and all in cages 2, 3 and 4. April 2, 8 were alive in cage 1; 9 in cage 2 and 4 in cage 3.

Experiment 12, tried March 31st, exposure 1 hour with 6 drams of cyanide. All were apparently dead at the end of fumigation. April 1, 1 was alive in cage 3; all were dead April 5.

Experiment 13, March 31, an exposure of but 1 hour with 6 drams of cyanide. April 1 there was 1 larva alive in cage 1; 5 in cage 2 and all in cage 3. April 2, 3 were alive in cage 1, 5 in cage 2 and all in cage 3. April 5, 1 larva was alive in cage 2 and 7 in cage 3.

Experiment 14, March 31, an exposure of ½ hour with 6 drams of cyanide. April 1 all the larvae were alive in cage 1,

[1] The caterpillars used in this and succeeding experiments of this series were taken from nests on recently imported stock and received at Albany, March 27, 1909.

7 in cage 2 and all were dead in cage 3. April 2 all were alive in cage 1, 8 in cage 2 and 3 in cage 3. April 5, 4 were alive in cage 1; 2 in cage 2 and 1 in cage 3.

Experiment 15, April 1, the exposure being 1 hour with 6 drams of cyanide. April 2, 5 were alive in cages 1 and 2 and 2 alive in cage 3. April 3, 4 were alive in cages 1 and 2 and all dead in cage 3. April 5 none were alive in cages 1 and 3 and 3 alive in cage 2.

Experiment 16, April 1, exposure 1 hour with 8 drams of cyanide. Examination April 2 to 5 showed that all had been killed.

Experiments with scalecide

January 20, 1909

Experiment	Dilution	Time	Number of caterpillars	Observations
1	1–20	1 min.	10	Dead, the 21st
2	1–20	½ "	10	" " "
3	1–40	1 "	10	Alive the 21st, 5 alive the 22d
4	1–40	½ "	10	Dead the 21st, 22d

Observations on experiments. Series 1 apparently shows that nearly dormant free caterpillars can be destroyed by 3 hours fumigation, using 1 ounce of cyanide to 100 cubic feet of space. A scrutiny of the records also reveals the fact that this amount of cyanide can not be depended upon to kill the insects within their nests. One half this strength, namely 1 ounce to 200 cubic feet of space can not be relied upon to destroy free caterpillars if the fumigation be continued 3 hours though all succumb after a prolonged exposure to the gas such as 21 hours.

Series 2 apparently indicates a most satisfactory method of destroying these pests were it not for the fact that the caterpillars, prior to the experiments, had been in a warm room of the office for several days and were therefore aroused to nearly normal activity.

Series 3 apparently gives very satisfactory results if the fumigation be continued even 1 hour, provided 1 ounce of cyanide be used to each 100 cubic feet of space. Unfortunately, these caterpillars had been exposed to a moderate temperature for at least a day and were hardly in the hibernating condition.

Series 4 is practically a duplicate of series 3 and apparently gave very satisfactory results.

Using the data obtained in the preceding series as a guide, more elaborate experiments were conducted in the cubical box and its cages described on a preceding page. The larvae in this series had not begun to crawl to any extent and were therefore practically in a hibernating condition. It will be seen by reference to the table that fumigation for 3 hours with 1 ounce of cyanide to 100 cubic feet of space can not be relied upon to destroy all the caterpillars in the various cages though the diffusion of the fumes was checked by no more serious obstacle than the open mesh of cheese cloth. In fact, the lack of uniform action in the different cages and the apparently feeble penetrative power of hydrocyanic acid gas was something of a surprise. A reference to the records of the various experiments under this series shows that the results are more or less contradictory and unsatisfactory, plainly indicating the unreliability of hydrocyanic acid gas for the destruction of the hibernating caterpillars of the brown tail moth. This is especially true if the caterpillars are in their winter nests and not freely exposed.

The tests with scalecide diluted one part to 20 resulted in the death of all the caterpillars even when the period of immersion was limited to half a minute.

Codling moth

Carpocapsa pomonella Linn

The codling moth must be regarded as one of the most injurious of our fruit insects, since it occurs throughout the apple-producing sections of this country. The apple worms or young of this pest may be found in from 25 to 60 or more per cent of the fruit in many regions. This gives an idea of how very injurious it may be, since the value of an apple is seriously affected by the presence of the apple worm. Dr S. A. Forbes, State Entomologist of Illinois, in 1887 estimated the annual loss caused by this insect in that state at $2,375,000. A similar calculation for Nebraska in 1892 placed the damage at $2,000,000, while in 1898 the late Prof. M. V. Slingerland estimated the annual loss caused by this insect on the apple and pear crop of New York State at $3,000,000. An estimate of the injury for the entire United States, made in 1908, puts the damage at $12,000,000; aside from the cost of spraying, which latter amounts to from $3,000,000 to $4,000,000 [Quaintance '08]. Those conversant with the situ-

ation will agree that the above figures are conservative and probably greatly understate the actual loss.

Early history

It should not be understood that the apple worm or codling moth is a recent insect pest, though there was a time when this species was unknown in America. Undoubtedly Cato had this form in mind when writing about wormy apples nearly 200 years B. C. Pliny also mentions this pest, though the true history of this insect, according to the late Professor Slingerland, begins with the brief account of Goedaerdt, published in 1635. Several European writers discussed the insect in the next and following century.

The first notice of this species in American literature was occasioned by the rearing of a moth from plums instead of the familiar plum curculio. Dr T. W. Harris, our first economic entomologist, established in 1832 the identity of the American apple worm with the well known European species. Subsequently, numerous accounts were published by earlier workers, while the developments of recent years have shown the wisdom of making more careful studies of this species. The result is an enormous literature, much of it a repetition of facts ascertained by early investigators. The more recent discussions of this insect have almost invariably been preceded by original investigations and have therefore added something to our knowledge of this pest.

Origin and distribution

This insect is doubtless a native of southeastern Europe, though it is now known to occur in almost every part of the world where apples are grown. South Africa and Australia made determined efforts to exclude the pest and were successful for some years. This moth was probably brought into the United States in the latter part of the 18th century, since it was not recognized in America till 1819, at which time wormy fruit was common in the vicinity of Boston. It was prevalent in the New England States by 1840 and was at that time well established in central New York. It was recognized in Illinois in 1849, Iowa about 1860, Utah 1870 and appeared in California the spring of 1874. There may be a few isolated fruit regions in the far West where the insect has not yet become established. It is only a question of time before it will make its way to these remote places.

The wide dissemination of this insect is undoubtedly accomplished by the shipment of infested fruit, or by means of infested boxes and barrels. This latter is easy, since the apple worms spend the winter in well protected cocoons.

The experience of the last 40 years has abundantly demonstrated the practicability of control measures. The problem before us at the present time is to determine the most economical method of accomplishing this desirable result. A knowledge of the insect and its habits is a necessary preliminary to success.

Life history and habits

Summary of habits. It is well known that the apple worm winters in a tough, silken cocoon, frequently found under the rough bark of trees. With the advent of warm weather in the spring, which in New York means late April and early May, the caterpillars begin to transform to pupae, and a week or 10 days after the blossoms drop, the moths commence to emerge and continue to appear throughout the greater part of June. The minute, whitish eggs, as determined by recent investigations, are deposited largely upon the leaves, though a number may be found on the young fruit. These hatch in about a week and, as a consequence, the young worms of the first brood may be entering the small apples from early in June to nearly the end of the month or even later. The caterpillars require about four weeks to complete their growth, at which time they desert the fruit, wander to a sheltered place, spin a cocoon, transform to pupae, and in about two weeks, namely, the last of July or in early August, another brood of moths appear. These in turn deposit eggs which hatch in due time and the young larvae enter the fruit. A larger proportion of this brood enter at the side of the apple than is the case with the first generation of larvae. Two broods appear to be the rule in the northern fruit-growing sections of the United States at least, though some investigators claim a third in the southwest, in particular.

It is important for the fruit grower, if he would obtain the best results in his efforts to control this pest, to know more than the bare outline given above. We will therefore proceed to discuss certain phases of the life history of the insect in some detail.

Food habits. This insect is best known as an apple pest, though its occurrence in pears is by no means uncommon. Some crab apples at least, and quinces are very subject to injury. It is also known to infest peaches, plums, prunes, apricots and cherries.

There are records of this species having been reared from chestnut and walnut, though in some instances at least, the evidence is not so conclusive as might be desired.

Hibernation. The codling moth winters as a caterpillar in a silken cocoon spun in some sheltered retreat, especially under the bark of trees. The full-grown caterpillar usually excavates an oval cavity about half an inch long, occasionally penetrating to the living tissue, in the bark and spins its cocoon. This latter probably occurs frequently under boards, rubbish, fences etc., in the vicinity of infested trees. Simpson ['01] observed a number of cocoons under clods of earth and in crevices, while Sanderson ['08] found that 30% of the cocoons on seven trees in a badly infested, old orchard were on the main branches, the remainder being on the trunk, the great majority of the latter occurring either close to the crotch or within a foot of the ground. The occurrence of cocoons in the soil or in the grass under infested trees is certainly exceptional, since a careful examination by Beal in 1875, resulted in finding none. It is well known that worms leaving infested fruit after it is barreled or stored, will spin their cocoons in crevices and angles of barrels or in almost any convenient shelter. They display a marked preference for the folds of fabrics, a habit turned to good account when we employ burlap or other bands. The apple worms have even been known to injure books in an effort to find a safe place in which to transform.

It only requires casual observation to show that winter is a time of great mortality for apple worms. A tree badly infested in the fall may be nearly cleared of the pest in the spring. An examination of seven badly infested, old trees [Sanderson '08] showed that out of 269 larvae, only 5% were alive, 87% having been destroyed by birds, 4% killed by fungus and 3% apparently succumbing to cold.

Pupation. Transformation to the pupa is coincident with the appearance of warm weather and occurs in New York State [Slingerland '98] the latter part of April and in early May. Sanderson ['08] records transformation to this stage at Durham, N. H., in 1908 from May 20 to June 9, and the preceding year, May 18 to June 23, the average duration of this stage being 16 days. The New Hampshire records, it should be observed, are later than those of Ithaca, N. Y., the divergence being easily accounted for by the difference in latitude and climate.

The moth and its habits. The moth has a wing spread of about ¾ of an inch and is an obscure, grayish brown and bronze color. Near the tip of the forewing there is a large, dark brown spot marked with streaks of bronze or gold. The male is distinguished by the black pencil of hairs on the upper surface of the hind wing and a black spot on the under surface of the forewing. The emergence of the moths from the cocoon, like the transformation of the larvae to the pupae, extends over a considerable period.

There is a correlation between the flight of the parent insects and the blossoming of the apples, though the latter varies somewhat according to weather conditions and the variety. Observations extending over three years [Sanderson '08] show that the first moth in New Hampshire appeared from a few to about 10 days after the petals fell, the majority of the moths being abroad two or three weeks after the blossoms dropped and the last adults being observed nearly a month after the falling of the bloom. The records of several observers show that moths may live from two to about four weeks. The parent insect is nocturnal though not attracted to lights to any extent, feeds freely upon cut fruits and sweets, and on account of its colors harmonizing with the bark upon which it rests, usually escapes observation.

It is difficult to reconcile Melander's belief ['08] that the codling moth may be so local as to even have a home tree, with the contradictory results obtained in some experiments on adjacent trees, where the infestation appeared to increase with the number of sprayings. Professor Ball ['04] states that a few moths may be carried by the wind several miles. It is interesting to note that observations by Cordley ['02] suggest that the moths may not deposit eggs in Oregon when the evening temperature falls much below 60° F.

Eggs. The small, whitish or yellowish eggs of this insect may be deposited upon the foliage or fruit, and to the unaided eye, appear, when fresh laid, much like a minute drop of milk about the size of a small pin head. A careful study [Sanderson '08] shows that out of 796 eggs actually observed, 787 were deposited upon the leaves, nearly equal numbers being upon the upper and under surface, while only seven were seen on the fruit and five on the bark. These eggs were from a few to 16 or even 28 inches from any fruit, with an average distance of approximately 9 inches. The record shows that the moths make no particular effort to deposit the eggs upon the fruit, and also that large num-

bers may be laid on leaves of barren limbs. There was nothing in the records to show that proximity of eggs had any material influence upon the fruit becoming infested. Similarly, Pettit ['04] found some 86% of the eggs on the foliage. Females may deposit from 29 to 136 eggs, the average running probably from 60 to 75. According to Sanderson ['09] the laying of eggs may be considerably delayed by cool weather. Hurst ['09] holds that the eggs may be killed if the temperature drops to 36° F. Thus a cool period in late May or early June may result in comparatively few wormy apples. The duration of the egg stage depends somewhat upon temperature conditions and in New Hampshire [Sanderson '08] it was found to be a trifle over eight days. Simpson ['03] gives the average as 11 days.

The appearance of the majority of the moths two to three weeks after the dropping of the petals and, adding to this the time necessary for the hatching of the eggs, shows that the major portion of the young apple worms can not attack the fruit till three to four weeks after the falling of the bloom.

Habits of the larva. The young larva, which is only about 1/16 of an inch long, whitish, black spotted and with a black head, feeds [Sanderson '08] first upon the foliage, mining into the leaf at the angles of the midrib and branch veins and gnawing the softer portions of the surface. It is possible that some may attain maturity without entering fruit, since Dr Headlee succeeded in obtaining a pupa from one which grew to full size in a water sprout. Usually the appetite for fruit asserts itself early and the young larva starts in search of an apple. The blossom end is highly favored, since some two thirds or more of the total enter at this point, feeding first in the calyx cavity and then making a more or less direct path to the core. The young larvae exhibit a marked preference for the seeds and the tissues in the immediate vicinity. Rarely do we find more than two worms coming to maturity in the same apple, even on very badly infested trees. The time spent in the apple is variable, several investigators giving records from 10–14, 16–24, 20–30, 25–30 and 34 days. The average is probably not far from four weeks, though the duration of this stage is dependent to some extent upon the temperature. The full-grown apple worm is about 3/4 of an inch long, with a conspicuous, brown head and a whitish or frequently pinkish body. It forsakes the apple upon attaining maturity and seeks some secure place prior to excavating a

cavity, if this be necessary, and spinning its rather firm, whitish cocoon. A large percentage, over 90 in some instances [Hurst '09], desert the fruit while it is still on the tree and crawl down the limbs and trunk. Gillette ['00] has shown that there may be some movement or migration of the larvae in the spring prior to the transformations to the adult.

Second generation. The early larvae, at least of the first brood, completing their growth from the middle to the latter part of July, transform, shortly after spinning up, to pupae and produce moths which, in New York State, appear late in July or during August. The second brood larvae are much more likely to enter the fruit at the side than is the case with the first generation. Very frequently a portion of a leaf attached to the side of the apple, is utilized as a point of entry or the apposed surfaces of two apples hanging side by side may be similarly employed. The evidence at hand shows there is only a partial second brood in New Hampshire, a partial to a full second brood in New York State, while in the southwest there are those who claim a partial third brood.

Natural enemies. The codling moth, despite its destructiveness, is subject to attack by a number of natural enemies, some of which are exceedingly efficient. Those examining trunks of apple trees in the spring, very frequently come across the characteristic cocoons of this insect, many of them with an irregular, jagged hole showing where a bird had extracted the inhabitant. The destruction of 87% [Sanderson '08] of such cocoons is striking testimony to the efficiency of these forms. The downy woodpecker and the nuthatchers are among the most beneficial. It is probable that all woodpeckers frequenting orchards feed on codling moth larvae. Other birds known to do so, in addition to the above named, are the black-capped titmice, wrens, bluebirds, crows, blackbirds, king birds, swallows, sparrows, chickadees and jays. A bat has been observed in California diligently capturing moths.

There are a number of predaceous and parasitic insects known to prey upon this fruit pest. The larvae of the soldier beetles, Chauliognathus pennsylvanicus and C. marginatus attack the apple worm. The 2-lined soldier beetle, Telephorus bilineatus, an ally of the preceding and likewise common, has similar habits in its larval stage. Two other related forms, Trogosita corticalis and T. lati-

collis have similar habits. Two ground beetles, Pterostichus californicus, Calathus rufipes, and several Dermestid or scavenger beetles, such as Trogoderma tarsalis and Perimegatoma variegata have been recorded as enemies. Other predaceous beetles undoubtedly destroy some larvae. A solitary wasp, Ammophila, in Utah, uses codling moth larvae to stock its nest, while Sphecius nevadensis was observed capturing these larvae in California.

Though the egg of the codling moth is so very tiny, it is not too small for the development of a small egg parasite known as Trichogramma pretiosa. The late Professor Slingerland records obtaining four from one egg. The delicate long sting, Macrocentrus delicatus has been reared from this insect. An ally known as Pimpla annulipes subsists upon this host. A parasitic fly, Hypostena variabilis is recorded as one of the enemies of the codling moth. These insect enemies, though numerous in variety, are rarely abundant enough to have any very material influence in reducing the numbers of this insect.

We have heard in late years, considerable in relation to a parasite, Caliephialtes messor Grav. recently introduced in California in the hope that it would prove of material service in controlling the codling moth. We regret to state that the developments of the last year or two have been disappointing, and it is doubtful if this species will ever be ranked as an important enemy of the codling moth in this country.

Control measures

Destruction of fallen fruit

The destruction of fallen fruit is by all means advisable provided it does not involve too much labor or expense. Unfortunately, a considerable proportion of the apple worms may desert the fruit on the trees and therefore escape destruction in this manner.

Trap lights

Trap lights have been warmly advocated at irregular intervals, though so far as careful investigations show, the benefits resulting from their use are inappreciable. Garman, in a series of experiments, found only 1.6% of his captures to consist of this species.

Banding

In the use of bands we take advantage of the apple worms' predilection to search out retreats, especially under fabrics on the trunk of the tree and, as a consequence, a considerable proportion may be captured in this way. It has been found by careful experiments that a large percentage of the worms infesting apples may desert the fruit while on the tree, crawl down the limbs and establish themselves in suitable retreats, rather than drop from the trees, crawl to the base of the trunk and ascend. There is no doubt as to the benefit resulting from bands carefully tended throughout the season. Unfortunately so much labor is involved that this method finds comparatively slight favor in the Eastern States.

Scraping the trunk

This is undoubtedly of service, since it reduces the number of retreats where codling moth larvae can hibernate in safety. There is a question as to the actual benefit to be derived, as repeated examinations in the orchard have shown that a very large percentage of the apple worms hibernating under the bark are destroyed by birds and other natural agents.

Screening fruit cellars

More or less wormy fruit is carried into storehouses and fruit cellars, and the larvae escape and hibernate in such places. It is advisable, where fruit trees are in the vicinity, to prevent the moths escaping in the spring, by closely screening windows and doors.

Spraying with poisons

The experience of the last 30 years has abundantly demonstrated the efficacy of poisoned sprays, provided the applications are timely and thorough. Many experiments conducted in the varied fruit sections of this country show that it is possible by this method alone, to obtain 90, 98 or even 99% of worm-free fruit, much depending upon the time when the work is done and the thoroughness of the treatment.

Materials. The poisons most generally employed against the codling moth in New York State at least, are paris green, arsenite of lime or arsenite of soda, and arsenate of lead, listing the materials in the order in which they were brought to notice. There is no question as to the value of paris green and its close allies, particularly if used in connection with bordeaux mixture,

since the latter aids materially in keeping the preparation upon the trees. Thorough and continuous agitation is necessary when paris green is used and should not be overlooked with other poisons. The arsenite of lime[1] is the cheapest poison which can be employed and has been extensively used in the fruit-growing sections of western New York. It is comparatively safe if used with bordeaux mixture. In recent years large amounts of arsenate of lead, usually a commercial preparation sold under a trade name, have been employed with great satisfaction. This poison is much more adhesive by itself than either paris green or arsenite of lime, and on account of its insolubility is much less likely to injure the foliage by burning. It is one of the safest poisons which can be employed. Arsenate of lead should be purchased on a guaranty as to the amount of arsenic contained, since there is considerable variation between the different brands. It is not particularly profitable for the fruit grower to pay for filler. It is the poison he is after.

The experience of the last two seasons has shown that it is possible to use a poison, especially arsenate of lead, with a dilute lime-sulfur wash (one of the standard commercial washes diluted with 30 parts of water). The advantage of this combination lies in the fact that so far this dilute lime-sulfur wash has caused no material injury to either foliage or fruit, while it has proved most effective as a fungicide and the poison has in no manner lost its efficiency as an insecticide. It should certainly be tried further, though the results thus obtained do not warrant unmodified recommendation.

A word as to the possibility of ultimate injury to orchards receiving one or more applications annually, of an arsenical poison. Prof. William P. Headden of Colorado has published a bulletin giving a warning in regard to this matter and stating that in his opinion, many trees in that state were being killed by applications of poison. It is but fair to state that other investigators in an adjacent state and one in New York State attribute the injury to other causes. So far as the writer can

[1]Arsenite of lime may be prepared by dissolving 1 pound of white arsenic and 4 pounds of sal soda (carbonate of soda, washing soda) in 1 gallon of water by boiling in an iron vessel 15 minutes or till the arsenic dissolves, leaving only a little muddy sediment. Add the water lost in boiling and use 1 pint of this stock solution to each 40 gallons of water to which 2 pounds of freshly slacked lime have been added, or a pint of the stock solution may be added to 40 gallons of bordeaux mixture. This stock solution will keep indefinitely in a closed vessel. It is very poisonous and should be properly labeled.

ascertain, the use of poison in Colorado and adjacent fruit-growing sections, has been much more liberal than in the East, and the probabilities are that similar trouble, if it be due to poison, will not manifest itself to any great extent in New York State for some years to come. Nevertheless, it is not only more economical but it is by all means advisable to bear this in mind when spraying and to endeavor to secure a maximum result with a minimum of poison.

Dry poisons. The application of poisons dry, frequently termed "dust spraying," has been warmly advocated in recent years, though careful experiments show that the dry method is less effective in controlling codling moth. It may be advisable in localities where the nature of the land or other conditions make it almost impossible to use the heavier outfit necessary for applications of liquids. The drifting or blowing dust is very annoying, since it is almost impossible to dodge it entirely, and furthermore, there is, in our judgment, more danger of ill effects to the operator resulting from the continued use of this material.

Apparatus. There are now on the market a number of good spray pumps and spraying outfits. The selection of any one to the exclusion of others, must be decided very largely by local conditions. The essentials in a spraying outfit, be it large or small, are ample power, sufficient mobility, plenty of hose and a nozzle extension or other arrangement so as to permit of the thorough and rapid covering of the foliage with the insecticide or fungicide. A tower is almost invaluable in a level orchard and of little service in a hilly one. We believe it advisable for the beginner to invest in a hand outfit and learn by actual experience whether his conditions justify the purchase of the much more efficient and correspondingly expensive power outfit.

The extended experience with spray apparatus of various kinds in eastern Massachusetts, has resulted in several improvements which may be of material benefit to our fruit growers. One of considerable utility is the long-tailed coupling, a device which does not reduce the diameter of the hose at the point of coupling, and furthermore permits the attachment of two broad bands to each portion of the coupling, thus preventing "blow offs" almost entirely. Another handy device is the "gooseneck," which is nothing more than a short piece of bent pipe attached to the usual horizontal connection, so that the hose

may be screwed to it at an angle of about $45°$ from the horizontal, thus obviating in large measure the tendency of the hose to break at the end of the coupling, owing to its hanging therefrom at a nearly right angle. High power outfits capable of developing 200 pounds pressure are being used in the gipsy moth work, with a solid stream nozzle, experience showing that on high trees at least, a very fair spray is secured under such conditions. This method could probably be used to advantage on large orchard trees.

Methods. There has been more or less difference of opinion as to the relative efficacy of a coarse or fine spray in work against the codling moth. This has culminated in recent years in some very strong statements made in favor of employing a rather coarse spray and an unusually high pressure in an effort to drive the poison into the lower calyx cavity, that is the cavity below the stamens. It is hardly necessary to remind fruit growers that after the white petals have dropped we have the green calyx lobes and within a ring of numerous upright, slender stamens surrounding the central, fleshy pistil. Below the stamens and at the base of the pistil there is an appreciable cavity [pl. 19, fig. 1]. This is the place, according to some authors, where the poison must be put if we would obtain fairly satisfactory results. One writer has even gone so far as to state that if spraying is not done in this manner the small apple worm is fairly safe, since it rarely feeds before it goes down into the lower cup, and that the poison sprayed on the outside will therefore not affect it. The claims for this method of spraying were so strong that the problem seemed one worthy of careful demonstration, and the writer therefore planned and conducted a series of experiments for the purpose of obtaining data upon this proposition.

Experimental work. The main purpose of these experiments was to test the relative efficiency of a coarse driving spray, such as that produced by a typical Bordeaux nozzle with a pressure of over 100 pounds in comparison with the fine, misty spray of the Vermorel nozzle and its various modifications so extensively used in the eastern United States.

Comparisons were made between single sprays of each of the above mentioned kinds applied just after the blossoms fell, between two sprays of each kind, one given just after the blossoms fell and the second just before the sepals closed and finally, between two such sprays and a third applied with a

Friend nozzle (an improvement of the Vermorel type) the last week in July for the purpose of destroying the second brood of the codling moth. The first test was duplicated in the orchard of Edward Van Alstyne at Kinderhook, N. Y.

Treatment of plots

Vermorel nozzles. Plot 1. An early spray just after the blossoms fall; plot 2, the same as above and a second spray before the calyx lobes close; plot 3, the same as plot 2 but with an additional spray, using a Friend nozzle the latter part of July for the second brood.

The spraying with these nozzles followed the usual practice of orchardists, the aim being to cover the entire tree, including the tips of the young apples, with a fine, misty spray.

Bordeaux nozzles. Plot 4. One application just after the blossoms fall; plot 5, the same as plot 4 but with a second spraying just before the calyx lobes close; plot 6, the same as plot 5 but with a third application with a Friend nozzle the last of July for the control of the second brood.

The nozzles were set so as to give a maximum of rather coarse spray which would not break up into fine spray until about 6 feet from the nozzle. The aim of the application was to drive the poison straight down into the tip of every young apple, the nozzle being held about 18 to 24 inches from the fruit so far as possible. The pressure was maintained at about 150 pounds.

Location and treatment of plots. The above series of experiments were conducted in a young orchard belonging to Mr W. H. Hart of Arlington, N. Y. near Poughkeepsie and located close to Briggs Station on the Hopewell branch of the Central New England Railroad. The orchard is on a moderately high hill, the trees being thrifty, about 15 years old, 15 to 18 feet high and 30 feet apart. The actual experimental trees were Baldwins though some of the barrier trees were Northern Spy. Each plot consists of approximately 42 trees, 6 trees in a row one way and 7 in a row the other way, the central 6 being the actual experimental trees. These latter were carefully selected for uniformity in size, fruitage and infestation. An examination of one tree resulted in finding 13 empty codling moth cells and in another none. These were not in experimental areas. The orchard as a whole had not been sprayed much prior to this year. A road runs along the

southern edge of the orchard and at the southeast corner there is an old orchard which was pastured all last summer and is probably not a serious disturbing factor so far as infestation by codling moth is concerned.

Plots 2 and 3 were located on two rows of Baldwins near the top of a hill, Northern Spys lying on either side and being used as east and west barrier trees. Plot 2 consists of 6 very uniform trees. Plot 3 was farther north on the same row and included, among the experimental trees, two which were not up to standard so far as fruiting or size is concerned. These two were not considered, the estimates being restricted to the 6 satisfactory ones. The experimental trees of plot 1 were remarkably vigorous and heavily fruited. Plot 4 was in the southeast portion of the experimental area next the old orchard mentioned above [*see* pl. 3]. Plot 5 was just west and a little north of plot 4, lying very nearly between the latter and plot 2. Plot 6 was just north of plot 5. Plots 5 and 6 have two rows of Spys as barriers on the west. The latter plot, namely 6, has also two rows of Spys as barriers on the north. Two check trees, x and y were near the northwest corner of plot 4 [*see* pl. 3]. Plot 1 was northeast of the check trees.

First application, May 20. Plots 5 and 6 were sprayed with the Bordeaux nozzles, one on each line of hose. The western experimental trees of both plots 5 and 6 were treated perhaps a little more thoroughly than the eastern trees of the said plots. Plot 4 had the experimental trees only sprayed with Bordeaux nozzles, Friend nozzles being used on the barrier trees. Plot 1 was sprayed throughout May 20 with Friend nozzles, plots 2 and 3 were similarly sprayed May 21 between 11 a. m. and 3.15 p. m., plot 3 being sprayed last and completed about 1 hour before it began to rain. The Bordeaux nozzle, with a pressure of 150 pounds, gave a stiff, penetrating spray which repeatedly passed the stamens and collected in the lower cavity. This was true, not only of blossoms where the stamens had withered somewhat, but also of those still bearing petals. The first two experimental trees next the road were sprayed with 125 to 150 pounds pressure and all the barrier trees, the remainder of the experimental trees in plot 2 and all of the experimental trees in plot 3 were sprayed with a pressure of 145 to 150 pounds. There was a perceptible difference in the penetration of the calyx cup, the higher pressure being the more satisfactory, there

being in some instances a collection of spray at the bottom of the calyx cup in the latter case. All of the spraying was from the ground, the hose being tied to poles and the nozzles set at an angle so as to discharge almost directly into all the blossoms, except possibly a very few on the highest branches. The defect with the Bordeaux nozzle employed was that the spray was not sufficiently spread out to permit of a very desirable rapidity in operation. It was exceedingly difficult, with the nozzles used, to be certain of hitting every apple. It was, however, markedly penetrating, throwing a rather coarse, forcible stream 6 or 8 feet and usually hitting the limbs near the center of the tree with considerable force.

The Friend nozzle gave a very well distributed, moderately fine mist spray which lacked the penetration of the coarser Bordeaux spray. In a few instances minute drops of spray were observed just within the stamens but there was never any collection of moisture at the bottom of the cup, seen in the case of flowers sprayed with the Bordeaux nozzle. The spray from the Friend nozzle with 125 pounds pressure is so fine that it rarely collects or runs at least upon the floral organs and can usually be seen as minute globules adhering to various parts of the leaf and foliage.

Applications. 5¼ pounds of Grasselli's arsenate of lead, and 10 pounds of copper sulfate were used to each 150 gallons of spray, enough lime being added to neutralize the copper sulfate as determined by the ferrocyanide test. 140 gallons of this mixture, using one Bordeaux nozzle on each line of hose, sufficed to treat 56 trees. It required about 1 minute to spray a tree 15 feet high with 1 lead of hose. 150 gallons of the spray were applied to 55 trees with 2 leads of hose, 2 Friend nozzles on each. It likewise required about 1 minute to spray a tree. The pressure while spraying with the 2 Bordeaux nozzles was kept at about 150 pounds. The pressure with the 4 Friend nozzles was maintained at about 125 pounds.

The weather was almost ideal for spraying on the 20th, there being very little wind until in the late afternoon. The 21st the weather was cloudy, wind strong and fitful. About 90% of the blossoms had dropped from the Baldwins at the time of application.

Second application, May 31. The calyx lobes were still widely expanded though the stamens and the tip of the pistil had shriveled and in many cases adhered so as to form an almost impassable barrier even to the heavy spray from the Bordeaux

nozzles. Repeated examinations failed to show a satisfactory penetration by either type of nozzle though 145 or even 150 pounds pressure was employed. This condition was observed, despite the fact that the calyx lobes for the most part showed no signs of closing and were mostly turned back. This phenomena was particularly apparent in the swelling fruit which had evidently been fertilized and was not so evident in the case of smaller apples doomed to shrivel and fall. The stamen bars of the latter were more widely separated and therefore more easily penetrated by the insecticide.

The weather was fair, warm and with a light to rather stiff breeze, the latter being more prevalent in the afternoon. The pressure varied from 120 to 145 pounds. Adler's arsenate of lead was employed instead of the Grasselli applied earlier, simply because the stock of the latter had been exhausted. Two Friend nozzles passed 4 gallons of spray mixture in 1 minute and 10 seconds at 150 to 160 pounds pressure, while 1 Bordeaux nozzle with 150 pounds pressure took about 1 minute and 15 to 20 seconds to discharge the same amount of insecticide. The pressure while the Bordeaux nozzles were in use, varied from 125 to 145 pounds. The penetration was distinctly less than 10 days previously. The eastern experimental trees were covered fully as thoroughly as the western ones in each of the plots. Plots 2 and 3 and 5 and 6 were sprayed, 2 and 3 with the new type Friend nozzles and 5 and 6 with the Bordeaux nozzles.

Third application, July 28. Experimental plots 3 and 6 were sprayed for the third time, using 2 pounds of Adler's arsenate of lead to 50 gallons of water and bordeaux mixture made with 4 pounds of copper sulfate to 50 gallons of water, enough lime being added to satisfy the ferrocyanide test. The weather was warm, clear and with very little or no wind. 75 gallons were used on the 48 trees of plot 4 and nearly as much on the 48 trees of plot 6.

General observations. Several weeks after spraying, the check trees were plainly more wormy than those in the adjacent plots; the fruit as a whole was in excellent condition, the apples being from 1 inch to 1½ inches in diameter. Some of the trees had suffered from aphis attack and a portion of the fruit was more or less deformed. Generally speaking, the fruit conditions throughout the experimental plots were uniform, though some trees will bear much more fruit than others. The experimental trees on plot 4 showed considerable yellowing of the foliage,

which Mr Hart thought might be due to bordeaux injury, induced to some extent possibly by dry weather. This yellowing was much more evident on the experimental trees of this plot than on the trees in the adjacent plot 3.

Under date of June 17 Mr Hart reports a very satisfactory growth of fruit though aphids increased rapidly. The first week in June the infestation was restricted almost exclusively to the fruiting trees, and started upon the whorls of leaves under fruit spurs. There was the usual stunting and malformation of the fruit. He found that the infestation was more severe on the 4 lower experimental plots than in other portions of the orchard. July 13 he states that the aphids had almost completely disappeared and while they affected the uniformity of the setting, there was still much good fruit. The orchard, including the experimental portion, was plowed in June, fertilized broadcast with 600 pounds per acre of a fertilizer made up of 400 pounds of ground bone, 100 pounds of 2-9-6 fertilizer and 100 pounds of sulfate of potash. It was harrowed several times and seeded on the 6th with large and crimson clover and cow horn turnips. He saw at this time a little codling moth work but not as much as last year. September 9th he states that the trees sprayed the third time had lost much of their foliage. The Baldwins apparently lost half of their leaves and the Spys over half [pl. 8, fig. 2], due probably to the bordeaux mixture and not to the poison. The remaining foliage appears healthy and the fruit is growing. A larger proportion of the foliage was shed on the upper plots than on the lower ones, especially on the Baldwins. The leaves of the latter turned yellow and dropped, while those of the Spys dropped without discoloring.

Experimental data

The following tables give the records for the individual trees. Some 100,000 apples were carefully handled one by one and classified, as will be seen by reference to the following data. September 13 and 14 the dropped apples under all the trees were carefully gathered and later, October 5 to 7, the remaining fruit was picked and classified. It will be seen by reference to the detailed tables, that the dropped fruit from the various sprayed plots gave from 14.91 to 26.67% of wormy fruit, while the two check trees had 73.91 and 81.02%, respectively, of wormy fruit. These figures are mostly interesting because they show what a large percentage of the wormy fruit drops before picking time.

Plot I (Sprayed once)

	Tree	Date	Total fruit	CLEAN FRUIT Total	CLEAN FRUIT %	MARKETABLE FRUIT Total	MARKETABLE FRUIT %	MARKETABLE FRUIT bbls.	SMALL FRUIT Total	SMALL FRUIT %	WORMY FRUIT Total	WORMY FRUIT %	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
	A	Sept. 13-14	79	72	91.14						7	8.86			7	3	
		Oct. 5-7	4 970	4 866	97.88	2 973	59.80	2.75	1 893	38.08	104	2.12	6	6	92	74	6
Totals and %			5 049	4 938	97.77	2 973	58.87		1 893	37.50	111	2.23	6	6	99	77	6
	B	Sept. 13-14	92	88	95.65						4	4.35			4	2	
		Oct. 5-7	5 217	5 179	99.29	2 993	57.38	2.875	2 186	41.90	38	.72	3	1	34	20	7
Totals and %			5 309	5 267	99.23	2 993	56.38		2 186	41.18	42	.77	3	1	38	22	7
	C	Sept. 13-14	86	80	93.02						6	6.98	2		4	2	
		Oct. 5-7	3 721	3 696	99.32	2 276	61.16	2.80	1 420	38.16	35	.68	5		30	23	7
Totals and %			3 807	3 776	98.92	2 276	59.62		1 420	37.20	41	1.08	7		34	25	7
	D	Sept. 13-14	186	175	94.08						11	6.92	5	1	5	7	
		Oct. 5-7	8 559	8 514	99.48	3 739	43.69	3.5	4 775	55.79	45	.52	3	3	39	29	4
Totals and %			8 745	8 689	99.37	3 739	42.76		4 775	54.60	56	.63	8	4	44	36	4
	E	Sept. 13-14	47	40	85.10						7	14.90			7	7	
		Oct. 5-7	2 460	2 388	97.11	1 375	55.89	1.8	1 013	41.17	72	2.94	8	6	58	39	4
Totals and %			2 507	2 428	96.84	1 375	54.84		1 013	40.40	79	3.16	8	6	65	46	4
	F	Sept. 13-14	88	78	88.63						10	11.37			10	6	
		Oct. 5-7	4 662	4 642	99.59	2 465	52.87	2.5	2 177	46.69	20	.44	1	1	18	10	2
Totals and %			4 750	4 720	99.36	2 465	51.89		2 177	45.84	30	.64	1	1	28	16	2
Grand totals and % for plot			30 167	29 818	98.81	15 821			13 464	44.61	359	1.19					

Plot 2 (Sprayed twice)

	Tree	Date	Total fruit	CLEAN FRUIT							WORMY FRUIT						
				Total	%	MARKETABLE FRUIT Total	MARKETABLE FRUIT %	MARKETABLE FRUIT bbls.	SMALL FRUIT Total	SMALL FRUIT %	Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
	A	Sept. 13–14	29	28	96.55	......	......	......	......	......	1	3.45	......	......	1	1	......
		Oct. 5–7	2 142	2 127	99.29	1 227	57.28	1.75	900	42.01	15	.70	1	......	14	11	......
Totals and %	......	....	2 171	2 155	99.26	1 227	56.51	......	900	41.45	16	.74	1	......	15	12	......
	B	Sept. 13–14	48	38	79.16	......	......	......	......	......	10	20.84	......	1	9	9	......
		Oct. 5–7	1 574	1 554	98.72	1 095	69.57	1.125	459	29.10	20	1.28	1	......	19	14	......
Totals and %	......	....	1 622	1 592	98.15	1 095	67.50	......	459	28.29	30	1.85	1	1	28	23	......
	C	Sept. 13–14	5	5	100	......	......	......	......	......	......	......	......	......	......	......	......
		Oct. 5–7	221	215	97.28	155	70.13	.2	60	27.14	6	2.72	......	1	5	1	......
Totals and %	......	....	226	220	97.34	155	68.58	......	60	26.54	6	2.66	......	1	5	1	......
	D	Sept. 13–14	11	10	90.90	......	......	......	......	......	1	9.10	......	1	......	......	......
		Oct. 5–7	1 468	1 460	99.45	1 044	71.11	1.3	416	28.34	8	.55	......	......	8	7	......
Totals and %	......	....	1 479	1 470	99.39	1 044	70.58	......	416	28.12	9	.61	......	1	8	7	......
	E	Sept. 13–14	27	25	92.59	......	......	......	......	......	2	7.41	......	1	1	2	......
		Oct. 5–7	3 622	3 597	99.30	2 026	55.93	1.8	1 571	43.37	25	.70	1	3	21	13	3
Totals and %	......	....	3 649	3 622	99.25	2 026	55.52	......	1 571	43.04	27	.75	1	4	22	15	3
	F	Sept. 13–14	18	14	77.77	......	......	......	......	......	4	22.23	......	......	4	4	......
		Oct. 5–7	1 151	1 133	98.43	877	76.19	1.4	256	22.24	18	1.57	1	......	17	12	2
Totals and %	......	....	1 169	1 147	98.11	877	75.02	......	256	21.89	22	1.89	1	......	21	16	2
Grand totals and % for plot	......	....	10 316	10 206	98.93	6 424	62.27	......	3 662	35.49	110	1.07	......	......	......	......	......

Plot 3 (Sprayed three times)

	Tree	Date	Total fruit	CLEAN FRUIT							WORMY FRUIT						
				Total	%	MARKETABLE FRUIT Total	MARKETABLE FRUIT %	MARKETABLE FRUIT bbls.	SMALL FRUIT Total	SMALL FRUIT %	Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
	A	Sept. 13–14	97	87	89.69						10	10.31		2	8	8	2
		Oct. 5–7	2 101	2 082	99.09	1 470	69.96	1.9	612	29.12	19	.91	2	2	15	12	
Totals and %			2 198	2 169	98.68	1 470	66.87		612	27.84	29	1.32	2	4	23	20	2
	B	Sept. 13–14	25	18	72						7	18		1	6	6	
		Oct. 5–7	392	388	98.97	324	82.65	.6	64	16.32	4	1.03		1	3	2	
Totals and %			417	406	97.36	324	77.69		64	15.34	11	2.64		2	9	8	
	C	Sept. 13–14	59	52	88.13						7	11.87		1	6	5	
		Oct. 5–7	2 006	1 985	98.95	1 039	51.74	1.1	946	47.15	21	1.05	3	1	17	14	1
Totals and %			2 065	2 037	98.64	1 039	50.32		946	45.81	28	1.36	3	2	23	19	1
	D	Sept. 13–14	40	38	95						2	5			2	2	
		Oct. 5–7	1 220	1 218	99.83	762	62.45	.85	456	37.37	2	.17			2	1	
Totals and %			1 260	1 256	99.68	762	60.47		456	36.19	4	.32			4	3	
	E	Sept. 13–14	41	35	85.36						6	14.64			6	4	1
		Oct. 5–7	1 401	1 395	99.57	945	67.52	1.1	450	32.05	6	.43		1	5	6	
Totals and %			1 442	1 430	99.16	945	65.53		450	31.20	12	.84		1	11	10	1
	F	Sept. 13–14	158	151	95.56						7	4.44	2		5	4	
		Oct. 5–7	2 140	2 133	99.67	1 505	70.32	2	628	29.34	7	.33	1	1	5	3	1
Totals and %			2 298	2 284	99.39	1 505	65.49		628	27.32	14	.61	3	1	10	7	1
Grand totals and % for plot			9 680	9 582	98.99	6 045	62.44		3 156	32.60	98	1.01					

Plot 4 (Sprayed once)

	Tree	Date	Total fruit	CLEAN FRUIT							WORMY FRUIT						
				Total	%	MARKETABLE FRUIT			SMALL FRUIT		Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
						Total	%	bbls.	Total	%							
	A	Sept. 13–14	58	44	75.86	......	......	......	......	......	14	24.14	2	......	12	11	......
		Oct. 5–7	2 944	2 878	97.79	1 661	56.43	2	1 217	41.01	66	2.21	6	......	60	40	3
Totals and %	......	....	3 002	2 922	97.36	1 661	55.34	......	1 217	40.55	80	2.64	8	......	72	51	3
	B	Sept. 13–14	74	66	89.18	......	......	......	......	......	8	10.82	......	......	8	2	1
		Oct. 5–7	3 387	3 347	98.81	1 560	46.05	1.5	1 787	52.76	40	1.19	5	......	35	27	3
Totals and %	......	....	3 461	3 413	98.61	1 560	45.07	......	1 787	51.63	48	1.39	5	......	43	29	4
	C	Sept. 13–14	137	130	94.89	......	......	......	......	......	7	5.11	......	......	7	2	......
		Oct. 5–7	2 917	2 888	99.03	1 695	58.12	2	1 193	40.91	29	.97	2	1	26	21	1
Totals and %	......	....	3 054	3 018	98.85	1 695	55.53	......	1 193	39.07	36	1.15	2	1	33	23	1
	D	Sept. 13–14	95	88	92.63	......	......	......	......	......	7	7.37	1	......	6	3	......
		Oct. 5–7	3 941	3 901	98.98	1 917	48.64	1.9	1 984	50.34	40	1.01	7	1	32	24	2
Totals and %	......	....	4 036	3 989	98.84	1 917	47.49	......	1 984	49.16	47	1.16	8	1	38	27	2
	E	Sept. 13–14	54	48	88.88	......	......	......	......	......	6	11.12	1	1	4	2	......
		Oct. 5–7	1 662	1 631	98.13	982	59.08	.9	649	39.04	31	1.87	3	......	28	18	3
Totals and %	......	....	1 716	1 679	98.42	982	57.21	......	649	37.82	37	1.58	4	1	32	20	3
	F	Sept. 13–14	33	26	78.78	......	......	......	......	......	7	21.22	2	1	4	3	......
		Oct. 5–7	5 011	4 970	99.18	2 244	44.78	2	2 726	54.40	41	.82	2	2	37	24	8
Totals and %	......	....	5 044	4 996	99.04	2 244	44.49	......	2 726	54.04	48	.96	4	3	41	27	8
Grand totals and % for plot	......	....	20 313	20 017	98.55	10 059	49.30	......	9 556	46.84	296	1.45	......	......	......	......	......

Plot 5 (Sprayed twice)

	Tree	Date	Total fruit	CLEAN FRUIT Total	CLEAN FRUIT %	MARKETABLE FRUIT Total	MARKETABLE FRUIT %	MARKETABLE FRUIT bbls.	SMALL FRUIT Total	SMALL FRUIT %	WORMY FRUIT Total	WORMY FRUIT %	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
	A	Sept. 13–14	27	25	92.59						2	7.41		1	1	2	
		Oct. 5–7	967	954	98.65	741	76.62	1.2	213	22.02	13	1.35	1	1	11	5	
Totals and %			994	979	98.50	741	74.63		213	21.42	15	1.50	1	2	12	7	
	B	Sept. 13–14	69	61	88.40						8	11.60	1		7	2	
		Oct. 5–7	3 195	3 157	98.81	2 284	71.48	2.5	873	27.32	38	1.19	3	1	34	24	8
Totals and %			3 264	3 218	98.59	2 284	69.97		873	26.75	46	1.41	4	1	41	26	8
	C	Sept. 13–14	23	19	82.60						4	17.40		1	3	1	
		Oct. 5–7	3 337	3 316	99.37	1 543	46.20	1.3	1 773	53.13	21	.63			21	12	1
Totals and %			3 360	3 335	99.25	1 543	45.92		1 773	52.76	25	.75		1	24	13	1
	D	Sept. 13–14	27	23	85.18						4	14.82			4	3	
		Oct. 5–7	5 110	5 089	99.66	2 355	46.12	2	2 734	53.54	21	.44	2		19	16	2
Totals and %			5 137	5 112	99.51	2 355	45.88		2 734	53.26	25	.49	2		23	19	2
	E	Sept. 13–14	26	22	84.61						4	15.39			4	3	
		Oct. 5–7	3 828	3 771	98.56	2 271	59.35	2.4	1 500	39.22	57	1.44	2	4	51	45	5
Totals and %			3 854	3 793	98.49	2 271	58.95		1 500	38.94	61	1.51	2	4	55	48	5
	F	Sept. 13–14	42	37	88.09						5	11.91			5	4	
		Oct. 5–7	2 624	2 610	99.50	1 228	46.81	2	1 382	52.68	14	.50	1	1	12	9	2
Totals and %			2 666	2 647	99.32	1 228	46.07		1 382	51.85	19	.68	1	1	17	13	2
Grand totals and % for plot			19 275	19 084	99.01	10 422	54.08		8 475	43.98	191	.99					

Plot 6 (Sprayed three times)

	Tree	Date	Total fruit	CLEAN FRUIT		MARKETABLE FRUIT			SMALL FRUIT		WORMY FRUIT						
				Total	%	Total	%	bbls.	Total	%	Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
	A	Sept. 13–14	15	11	73.33	.....	.....	.....	.....	.....	4	26.67	1	.....	3	4	.....
		Oct. 5–7	752	735	97.73	495	65.82	.4	240	31.91	17	2.27	.....	.....	17	12	2
Totals and %	.....	....	767	746	97.26	495	64.53	.....	240	31.29	21	2.74	1	.....	20	16	2
	B	Sept. 13–14	33	29	87.87	.....	.....	.....	.....	.....	4	12.13	.....	1	3	2	.....
		Oct. 5–7	629	626	99.52	353	56.12	.8	273	43.40	3	.48	.....	1	2	2	1
Totals and %	.....	....	662	655	98.94	353	53.32	.....	273	41.23	7	1.06	.....	2	5	4	1
	C	Sept. 13–14	21	20	95.23	.....	.....	.....	.....	.....	1	4.77	.....	.....	1	1	.....
		Oct. 5–7	1 340	1 334	99.53	889	66.34	.7	445	33.20	6	.47	.....	.....	6	6	.....
Totals and %	.....	....	1 361	1 354	99.48	889	65.31	.....	445	32.69	7	1.25	.....	.....	7	7	.....
	D	Sept. 13–14	37	32	86.48	.....	.....	.....	.....	.....	5	13.52	1	.....	4	3	.....
		Oct. 5–7	876	866	98.85	452	51.59	.8	414	47.25	10	1.15	4	.....	6	3	1
Totals and %	.....	....	913	898	98.35	452	49.50	.....	414	45.34	15	1.87	5	.....	10	6	1
	E	Sept. 13–14	97	93	95.87	.....	.....	.....	.....	.....	4	4.13	.....	.....	4	2	.....
		Oct. 5–7	3 224	3 205	99.41	2 320	71.96	2	885	27.45	19	.59	.....	1	18	18	.....
Totals and %	.....	....	3 321	3 298	99.30	2 320	69.85	.....	885	26.64	23	.70	.....	1	22	20	.....
	F	Sept. 13–14	16	12	75	.....	.....	.....	.....	.....	4	25	.....	.....	4	3	.....
		Oct. 5–7	670	670	100	417	62.23	.....	253	37.76	.....	.....	.....	.....	.....	.....	.....
Totals and %	.....	....	686	682	99.41	417	60.78	.....	253	36.87	4	.59	.....	.....	4	3	.....
Grand totals and % for plot	.....	....	7 710	7 633	99	4 926	63.89	.....	2 510	32.55	77	1	.....	.....	.....	.....	.....

Check trees (Unsprayed)

	Tree	Date	Total fruit	CLEAN FRUIT								WORMY FRUIT						
				Total	%	MARKETABLE FRUIT			SMALL FRUIT								
						Total	%	bbls.	Total	%	Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
	X	Sept. 13–14	216	41	18.98	......	......	......	......	......	175	81.02	57	69	49	114	10
		Oct. 5–7	2 389	1 896	79.29	923	38.60	.875	973	40.65	493	20.29	152	176	165	311	65
Totals and %	......	....	2 605	1 937	74.29	923	35.40	......	973	37.32	668	25.71	209	245	214	425	75
	Y	Sept. 13–14	69	18	26.09	......	......	......	......	......	51	73.91	27	19	5	24	2
		Oct. 5–7	577	411	71.23	225	38.99	.375	186	32.23	166	28.77	76	38	52	101	6
Totals and %	......	....	646	429	66.43	225	34.82	......	186	28.77	217	33.57	103	57	57	125	8
Grand totals and % for plot	......	....	3 251	2 366	72.73	1 148	35.29	......	1 159	35.62	885	27.27	......	......	......	......	......

Summary of plots

PLOT	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT			
		No.	%	No.	%	Range of % between trees	Range in no. between trees
1	30 177	29 818	98.81	359	1.19	.63 — 3.16	30 — 111
2	10 316	10 206	98.93	110	1.07	.61 — 2.66	6 — 30
3	9 680	9 582	98.99	98	1.01	.32 — 2.64	4 — 29
4	20 313	20 017	98.55	296	1.45	.96 — 2.64	36 — 80
5	19 275	19 084	99.01	191	.99	.49 — 1.51	15 — 61
6	7 710	7 633	99	77	1	.59 — 2.74	4 — 23
Check	3 251	2 366	72.73	885	27.27	25.71 — 33.57	217 — 668

It will be observed that in these tables we have separated the small fruit, the product largely of severe aphis injury. The significance of this data is discussed on page 75. It was incidental to the major investigation and has very little or no influence on the codling moth problem, aside from a probably slight reduction in the percentage of wormy fruit. A study of the results as a whole, is extremely interesting. It will be seen by reference to the table giving the summaries for each plot, that the three sprayed with a Friend nozzle, produced from 98.81 to 98.99% of worm-free fruit, the higher percentage being obtained on the plot receiving three applications. In a like manner, the three treated with a Bordeaux nozzle, yielded 98.55 to 99% of worm-free fruit, the slightly higher percentage, as in the preceding group, being obtained on the plot receiving three applications. This apparent lack of material benefit resulting from the second and third application, may be due in slight measure to the fact that the plots sprayed but once produced more apples than those receiving the second and third sprayings, though the difference is not uniform and the variation between the percentage of worm-free fruit does not coincide exactly with the difference in yield between the various plots. For example, between plots 2 and 3 there is a difference of only 636 apples out of approximately 10,000, a variation hardly large enough to materially influence the percentage of worm-free fruit. This latter is only .06 of 1% in favor of the trees receiving three applications. Similarly, on plots 4 and 5 there is a variation of but 1030 out of approximately 10,000 and a difference in the percentage of worm-free fruit of but .46% in favor of the trees sprayed twice. It can hardly be claimed, in view of

these figures, that the variation in the yield on the various plots has affected materially the results obtained, though there is a somewhat uniform though accidental (owing to the yield of the various plots) decrease in production with an increase in the number of poison applications.

The material benefits resulting from the application of poisons is well shown by our obtaining only about 72% of worm-free fruit on the check trees, while the sprayed plots produced from 98 to 99% of sound fruit. The observations upon the apples were checked by an examination of the trunks of the trees the following May. This showed that paper bands, accidentally left on check trees X and Y, sheltered numerous codling moth cocoons, there being some 60 on X and 50 on Y. Examination of bands on sprayed trees in other plots resulted in finding no codling moth larvae.

There is, it will be seen by reference to the detailed tabulations, and also the summary, more or less variation between the percentage of wormy fruit obtained from trees of the different plots. For example, in plots 1 to 3 this ranges from .32 of 1% to 3.16% or a difference of 4 to 111 wormy apples. On plots 4 to 6 we have a variation between individual trees, of .49 of 1% to 2.74% or a range of from 4 to 80 wormy apples. These variations can hardly be considered excessive if a moderate allowance is made for the difference normally obtaining in an orchard, and also for the difficulty of spraying every tree exactly alike.

Fruitfulness and infestation

PLOT	MAXIMUM TREE		MINIMUM TREE	
	No. fruit	% wormy	No. fruit	% wormy
1	8 745	.63	2 507	3.16
2	3 649	.75	226	2.66
3	2 298	.61	417	2.64
4	5 044	.96	3 002	2.64
5	5 137	.49	994	1.50
6	3 321	.70	767	2.74

A study of the results obtained on maximum and minimum trees, show that in plot 1, the maximum tree producing 8745 apples yielded but .63 of 1% wormy fruit, while the minimum tree producing 2507 apples had 3.16% wormy. Similar results, it will be seen by referring to the table showing the variation in individual trees, were found in the other plots. That these vari-

ations are mostly local and hardly of general application, is shown by a study of the figures for all the plots. There was, as pointed out previously, a remarkably uniform percentage of worm-free fruit throughout, despite the considerable variation in the product. The benefits of the second or third application must of necessity be restricted to reducing the 1 or 1½% of wormy fruit. It is hardly probable that equally good results could be obtained every year.

Summary of wormy fruit

PLOT	TOTAL FRUIT	RANGE OF TREES	END WORMY		END AND SIDE WORMY		TOTAL END WORMY		SIDE WORMY		EXIT HOLE 1		EXIT HOLE 2	
			Total	Range	Total	Range	No.	%	Total	Range	Total	Range	Total	Range
1	359	30–111	33	1– 8	18	0– 6	51	14.20	308	28– 99	222	16–77	30	2– 7
2	110	6– 30	4	0– 1	7	0– 4	11	10	99	5– 28	74	1– 23	5	0– 3
3	98	4– 29	8	0– 3	10	0– 4	18	18.36	80	4– 23	77	3– 29	5	0– 2
4	296	36– 80	31	2– 8	6	0– 3	37	12.50	259	32– 72	177	20– 51	21	1– 8
5	191	15– 61	10	0– 4	9	0– 4	19	9.94	172	12– 41	126	7– 48	18	0– 8
6	77	4– 23	6	0– 5	3	0– 2	9	11.68	68	4– 22	56	3– 20	4	0– 2
Check	885	217–668	312	103–209	302	57–245	614	69.37	271	57–214	550	125–425	83	8–75
FINE (PLOTS 1–3) CONTRASTED WITH COARSE (PLOTS 4–6) SPRAY														
1–3	567	....	45	1–8	35	0–6	80	14	487	28–99	373	16–77	40	2–7
4–6	564	....	47	2–8	18	0–3	65	11.50	499	32–72	359	20–51	43	1–8
Average	....	....	....	....	....	....	....	12.82	....	....	....	....	....	....

A study of the condition of the wormy fruit gives some interesting data as to the point of attack, though very little can be gleaned therefrom in favor of using a coarse spray with a heavy pressure, as compared with a finer spray and more moderate power. It will be seen by reference to the table above, that on plots 1 to 3, 10 to 18.36% of all the wormy apples were entered at the end, an average of 14% end wormy. Similarly, in the case of plots 4 to 6, the variation is from 9.94% to 12.50% or an average of 11.50% of end wormy apples in the total infested. Compare these percentages with the 69.37% end wormy of the infested apples on the two check trees. It will be seen at once that the major portion of the codling moth larvae destroyed, must have been killed in or about the blossom end because of the enormous reduction in the number of end wormy apples. A comparison between the percentages of the wormy apples entered at the end in plots 1 to 3 with those of plots 4 to 6, reveals, so far as this factor is concerned, a slight gain in favor of the coarse, heavy spray of the Bordeaux nozzle. On the other hand, comparisons between the totals for plots 1 to 3 and 4 to 6 respectively, show that the first produced 50,173 apples of which 98.87% were free from infestation, while the latter yielded 47,298 apples and had 98.81% of worm-free fruit, a difference of only .06 of 1% in favor of the finer spray. A comparison of the totals of the wormy fruit between these two series of plots given in the above table shows an equally close parallelism.

Experiments 1 and 4 were duplicated in the orchard of Edward Van Alstyne at Kinderhook, N. Y., the plots being located as shown on plate 4. In addition, a third plot designated as 7, was sprayed for the purpose of testing the results to be obtained from a still higher pressure, and an attempt was made to keep the gage up to 200 pounds. Plot 4, located near the barn, consisted of Greenings; plots 1 and 7 were Baldwins, the latter being seven rows north of the barn, on a knoll and a little to the east of the other plots, while the two check trees lay near the northern boundary of plot 1. Spraying began May 29. The weather was cloudy, threatening and with a little wind. There was a heavy shower from 1 to about 1.30 p. m. and another at 2 p. m. resulting in a cessation of operations.

The spraying May 29 was with the old type of Friend nozzle, which is considerably deeper than the latter make. The pressure

was maintained at 100 pounds; 4 pounds of Grasselli's arsenate of lead and 3 pounds of copper sulfate with lime enough to satisfy the ferrocyanide test was employed for each 50 gallons of the mixture.

The calyx lobes were mostly well turned back and all the petals were off; the pollen cells had begun to brown though there was no wilting of the stamen bars.

Owing to interruptions by rain noted above, but five experimental trees of plot 4 were sprayed, the northwestern one not being treated. The three southernmost rows of plot 4 were sprayed mostly from the north side, except the barrier trees on the west end of row 3 counting from the barn. Observations showed that the experimental trees in particular were very well covered with the poison.

Spraying was continued June 2, plot 4 being completed in the morning. The experimental trees of plot 1 were sprayed at 100 pounds pressure. There was practically no penetration to the inner calyx cavity. The tips of the pistils and stamens were dead and the calyx lobes partially closed. The afternoon was fair with a light breeze.

Plot 7 was sprayed June 3 with a pressure of 150-60 pounds, though tree 7 E had its western side sprayed when there was a very low pressure owing to clogging of the pump. The pressure was not constant and much of the time the nozzles were held too far away to give the best results, a fact strikingly illustrated by the condition of the fruit at picking time.

Plot 1 (Sprayed once)

	Tree	Date	Total fruit	CLEAN FRUIT Total	CLEAN FRUIT %	MARKETABLE FRUIT Total	MARKETABLE FRUIT %	SMALL FRUIT Total	SMALL FRUIT %	WORMY FRUIT Total	WORMY FRUIT %	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
	A	Sept. 17–18	101	91	90.09	......	......	......	......	10	9.91	2	3	5	10	......
		Oct. 12–13	2 445	2 417	98.85	2 269	92.8	148	6.05	28	1.15	1	1	26	18	2
Totals and %	......	....	2 546	2 508	98.51	2 269	89.12	148	5.81	38	1.49	3	4	31	28	2
	B	Sept. 17–18	198	189	95.49	......	......	......	......	9	4.51	2	1	6	6	1
		Oct. 12–13	3 017	3 001	99.46	2 846	94.33	155	5.13	16	.54	2	......	14	10	......
Totals and %	......	....	3 215	3 190	99.22	2 846	88.52	155	4.82	25	.78	4	1	20	16	1
	C	Sept. 17–18	143	142	99.30	......	......	......	......	1	.70	......	......	1	1	......
		Oct. 12–13	1 877	1 863	99.25	1 813	96.05	50	2.66	14	.75	1	......	13	9	2
Totals and %	......	....	2 020	2 005	99.25	1 813	89.75	50	2.47	15	.75	1	......	14	10	2
	D	Sept. 17–18	310	293	94.51	......	......	......	......	17	5.49	3	2	12	11	......
		Oct. 12–13	5 118	5 082	99.30	4 756	92.92	326	6.36	36	.70	6	2	28	16	3
Totals and %	......	....	5 428	5 375	99.02	4 756	87.61	326	6.00	53	.98	9	4	40	27	3
	E	Sept. 17–18	234	215	91.88	......	......	......	......	19	8.12	1	4	14	15	1
		Oct. 12–13	3 364	3 330	98.99	3 095	92.06	235	7.04	34	1.01	3	2	29	21	......
Totals and %	......	....	3 598	3 545	98.55	3 095	86.02	235	6.53	53	1.45	4	6	43	36	1
	F	Sept. 17–18	161	153	95.03	......	......	......	......	8	4.97	1	3	4	7	1
		Oct. 12–13	4 296	4 266	99.30	4 046	94.18	220	5.12	30	.70	1	......	29	20	4
Totals and %	......	....	4 457	4 419	99.14	4 046	90.77	220	4.93	38	.86	2	3	33	27	5
Grand totals and % for plot	......	....	21 264	21 042	98.96	18 825	88.52	1 134	5.33	222	1.04	......	......	......	......	......

Plot 4 (Sprayed once)

	Tree	Date	Total fruit	CLEAN FRUIT Total	CLEAN FRUIT %	MARKETABLE FRUIT Total	MARKETABLE FRUIT %	SMALL FRUIT Total	SMALL FRUIT %	WORMY FRUIT Total	WORMY FRUIT %	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
	A	Sept. 17–18	115	109	94.78	......	......	......	......	6	5.12	......	......	6	5	......
		Oct. 12–13	1 122	1 105	98.57	905	80.66	200	17.82	17	1.43	......	......	17	7	2
Totals and %	......	....	1 237	1 214	98.14	905	73.16	200	16.16	23	1.86	......	......	23	12	2
	B	Sept. 17–18	143	129	90.20	......	......	......	......	14	9.80	1	4	9	12	......
		Oct. 12–13	2 380	2 313	97.18	1 578	66.30	735	30.88	67	2.82	8	5	54	28	11
Totals and %	......	....	2 523	2 442	96.78	1 578	62.54	735	29.12	81	3.22	9	9	63	40	11
	C	Sept. 17–18	147	142	96.59	......	......	......	......	5	3.41	1	1	3	3	......
		Oct. 12–13	1 366	1 350	98.75	960	70.22	390	28.52	16	1.25	4	......	12	4	2
Totals and %	......	....	1 513	1 492	98.54	960	63.40	390	25.75	21	1.46	5	1	15	7	2
	D	Sept. 17–18	134	134	100	......	......	......	......	......	......	......	......	......	......	......
		Oct. 12–13	1 400	1 389	99.21	1 175	83.92	214	15.28	11	.79	......	2	9	6	1
Totals and %	......	....	1 534	1 523	99.28	1 175	76.59	214	13.95	11	.72	......	2	9	6	1
	E	Sept. 17–18	126	123	97.61	......	......	......	......	3	2.39	......	......	3	3	......
		Oct. 12–13	1 038	1 031	99.32	810	78.03	221	21.29	7	.68	1	......	6	2	2
Totals and %	......	....	1 164	1 154	99.14	810	69.58	221	18.98	10	.86	1	......	9	5	2
	F	Sept. 17–18	191	187	97.85	......	......	......	......	4	2.15	1	1	2	4	......
		Oct. 12–13	1 690	1 671	98.87	1 306	77.27	365	21.59	19	1.13	3	......	16	9	1
Totals and %	......	....	1 881	1 858	98.77	......	69.43	365	19.40	23	1.23	4	1	18	13	1
Grand totals and % for plot	......	....	9 852	9 683	98.27	6 734	68.34	2 125	21.55	169	1.73	......	......	......	......	......

Plot 7 (Sprayed once)

	Tree	Date	Total fruit	CLEAN FRUIT						WORMY FRUIT						
				Total	%	MARKETABLE FRUIT Total	MARKETABLE FRUIT %	SMALL FRUIT Total	SMALL FRUIT %	Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
	A	Sept. 17–18	173	164	94.79	......	......	......	......	9	5.21	1	1	7	4	......
		Oct. 12–13	3 205	3 167	98.81	3 059	95.44	108	3.36	38	1.19	......	3	35	10	5
Totals and %	......	....	3 378	3 331	98.61	3 059	90.56	108	3.19	47	1.39	1	4	42	14	5
	B	Sept. 17–18	167	150	89.82	......	......	......	......	17	10.18	2	5	10	14	......
		Oct. 12–13	1 621	1 585	97.77	1 498	91.79	87	5.98	36	2.23	1	2	33	14	1
Totals and %	......	....	1 788	1 735	97.03	1 498	83.78	87	4.90	53	2.97	3	7	43	28	1
	C	Sept. 17–18	234	217	92.73	......	......	......	......	17	7.27	2	1	14	12	1
		Oct. 12–13	2 515	2 455	97.61	2 034	80.87	421	16.73	60	2.39	2	2	56	33	2
Totals and %	......	....	2 749	2 672	97.23	2 034	73.99	421	15.31	77	2.77	4	3	70	45	3
	D	Sept. 17–18	135	122	90.37	......	......	......	......	13	9.63	......	......	13	12	......
		Oct. 12–13	3 154	3 108	98.54	3 010	95.43	98	3.10	46	1.46	2	......	44	25	5
Totals and %	......	....	3 289	3 230	98.20	3 010	91.52	98	2.98	59	1.80	2	......	57	37	5
	E	Sept. 17–18	196	155	79.08	......	......	......	......	41	20.92	7	13	21	31	3
		Oct. 12–13	3 229	3 101	96.03	2 993	92.67	108	3.34	128	3.97	24	2	102	109	10
Totals and %	......	....	3 425	3 256	95.06	2 993	87.38	108	3.15	169	4.94	31	15	123	140	13
	F	Sept. 17–18	240	220	91.66	......	......	......	......	20	8.34	5	1	14	18	......
		Oct. 12–13	4 222	4 173	98.83	3 907	74.81	266	6.30	49	1.17	5	2	42	32	1
Totals and %	......	....	4 462	4 393	98.45	3 907	87.56	266	5.96	69	1.55	10	3	56	50	1
Grand totals and % for plot	......	....	19 091	18 617	97.52	16 501	86.42	1 088	5.7	474	2.48	......	......	......	......	......

Check trees (Unsprayed)

	Tree	Date	Total fruit	CLEAN FRUIT						WORMY FRUIT						
				Total	%	MARKETABLE FRUIT		SMALL FRUIT		Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
						Total	%	Total	%							
	X	Sept. 17–18	415	143	34.45	......	......	......	......	272	65.55	108	108	56	202	20
		Oct. 12–13	3 455	3 054	88.39	2 938	85.03	116	3.35	401	11.61	158	108	135	224	27
Totals and %	......	....	3 870	3 197	82.62	2 938	75.91	116	2.99	673	17.38	266	216	191	426	47
	Y	Sept. 17–18	637	114	17.89	......	......	......	......	523	82.11	189	202	132	410	27
		Oct. 12–13	2 508	1 816	72.40	1 737	69.25	79	3.14	692	27.60	219	212	261	371	91
Totals and %	......	....	3 145	1 930	61.36	1 737	55.23	79	2.51	1 215	38.64	408	414	393	781	118
Grand totals and % for plot	......	....	7 015	5 127	73.08	4 675	66.64	195	2.77	1 888	26.92	......	......	......	......	......

Summary of plots

PLOT	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT		RANGE OF % VARIATION BETWEEN TREES
		No.	%	No.	%	
1	21 264	21 042	98.96	222	1.04	.75 — 1.49
4	9 852	9 683	98.27	169	1.73	.72 — 3.22
7	19 091	18 617	97.52	474	2.48	1.39 — 4.94
Check	7 015	5 127	73.08	1 888	26.92	17.38 — 38.64

Summary of wormy fruit

PLOT	TOTAL FRUIT	RANGE	END WORMY		END AND SIDE WORMY		TOTAL END WORMY		SIDE WORMY		EXIT HOLE 1		EXIT HOLE 2	
			Total	Range	Total	Range	No.	%	Total	Range	Total	Range	Total	Range
1	222	15–53	23	1–9	18	0–6	41	18.47	181	14–43	144	10–36	14	1–5
4	169	10–81	19	0–9	13	0–9	32	18.90	137	9–63	83	5–40	19	1–11
7	474	47–169	51	1–31	32	0–15	83	17.51	391	42–123	314	14–140	28	1–13
Check	1 888	673–1215	674	266–408	630	216–414	1 304	69.21	584	191–393	1 207	426–781	165	47–118

It will be seen by referring to the above tables that the results obtained at Poughkeepsie were confirmed in large measure by those secured at Kinderhook, plots 1, 4 and 7, respectively, producing 98.96, 98.27 and 97.52% of worm-free fruit, while the two check trees yielded only 73.08% of clean fruit. These percentages, it will be observed, are slightly lower than those obtained at Poughkeepsie and may be explained by local conditions. The trees were larger and probably somewhat more infested by codling moth. The application was with a hand pump and, as a result, there was more difficulty in maintaining an even pressure. The slightly lower percentage obtained in plot 7 was not due to the higher, approximately 200 pounds pressure, but is undoubtedly explainable by a lack of thoroughness in application, since only 95.06% of clean fruit occurred on one tree where the application was not quite as thorough as it should have been. This obviously reduced the percentage for the entire plot materially. It will be seen in this series, as in the preceding, that a considerable proportion of the benefit results in destroying the codling moth larvae at or in the calyx end of the fruit, since in the sprayed plots 17.51 to 18.9% of the wormy fruit was entered at the end, while 69.21% of the wormy fruit on the check trees was thus infested. It will be noted that a considerably larger percentage of the fruit was end wormy at Kinderhook, compared to our findings at Poughkeepsie.

The data submitted above justifies the expectation that under normal conditions as they are found in the Hudson valley at least, one thorough application of a poison within a week or 10 days after the blossoms fall, should result in protecting a very large percentage, 98 to 99%, of the fruit from codling moth injury. We would emphasize the necessity of thorough work, though by this we do not mean an effort to drive the poison into the lower calyx cavity, desirable though this may be on theoretical grounds, but thoroughness in covering the foliage, the young fruit, in particular the blossom end, a point favored, as our investigations show, by about 69% of the worms entering the apple. We would select a nozzle giving the most uniform and rapid distribution of spray without regard to penetration. This should not be understood as discouraging the employment of high pressure, since this is undoubtedly an important factor in thorough and rapid work, the latter being extremely desirable on account of the limited time when successful applications may

be made. We are satisfied that most excellent results can be obtained where conditions permit the employment of only moderate pressures.

It should be understood that such results can hardly be obtained upon trees in the near vicinity of others which have not been sprayed. It will be seen by reference to the preceding account of the habits of this insect, that the codling moth may breed upon trees bearing no fruit, consequently, we believe it will pay the fruit grower to spray all trees in a bearing orchard without regard to whether they are fruiting or not. Our experience last year demonstrated the necessity of very thorough work if the high percentages of worm-free fruit cited above, are to be obtained. One tree in a special plot, where spraying was less thorough than on the others, though not perceptible to the eye of a practical orchardist making the application, produced only 95.06% of worm-free fruit. We would suggest that thoroughness in the distribution of the poison, in an effort to cover every portion of leaf and fruit with minute particles of spray will, in the long run, prove more effective and satisfactory than the application of large amounts of poison, especially if the spray is used so liberally as to cause dripping.

It may appear to some that the above results are too good even for an experiment, not to mention the practical fruit grower. The facts of the case are that all our sprayings were made by fruit growers with apparatus at hand. The scientist simply insisted on good, thorough work. The spraying was not nearly so heavy as it might have been and could not on that account be deemed impractical.

Work of other experimentors

There is abundant evidence to show that our general results with the sprays were not markedly superior to what others have been able to obtain, whether they were located in New Hampshire, West Virginia or some other portion of the country. This aspect of the problem therefore requires little discussion. On the other hand, the tests with but one spray have not been so numerous and were mostly conducted under conditions where error could not be easily eliminated. Experiments very similar to ours were those of Sanderson ['08]. In 1907 he sprayed a plot of six trees once, just after the blossoms fell, using 2 pounds of arsenate of lead to a barrel of bordeaux, and in a yield of

10,742 apples, obtained only 3.9% wormy. Another plot of five trees received similar treatment with a mist spray and produced 24,316 apples, 1.88% being wormy. A third plot was sprayed like the preceding, except that it was drenched with a coarse spray. It comprised four trees yielding 8109 apples and produced 3.4% wormy fruit. Conversely, a plot of six trees sprayed in 1908 and producing only 21 to 930 apples each, yielded but 2657 apples, 13% being wormy. This latter approximates our results on trees bearing a very small crop. Almost invariably such trees produced a markedly higher percentage of wormy fruit than the more heavily laden ones. Gossard ['08] gave a plot of four trees but one application. They yielded 4836 apples and an average of 95.91% free from codling moth. Two of these trees had a small crop, otherwise the percentage of sound fruit would probably have been higher. One tree [Gossard '09] produced nearly 99% of sound fruit. Ball ['07] as a result of experiments conducted over a series of years, became convinced that the first spray or the first and second sprays, namely, the two given within a week or 10 days after the falling of the petals, would kill 90% of the first brood in Utah, thus destroying many of the progenitors of the second brood and, in addition, enough poison remained on the foliage to kill some 74% of the second generation of apple worms. He estimates that two early sprayings correctly applied, are worth from 6 to 16 times as much as three late ones. These two early sprays killed an average of 98% of the worms of the first brood entering the calyx, and 97% of those of the second, an average of 78% of the first brood entering the sides of the apple and 52% of the second brood attacking the apple in the same way. Melander, apparently basing his recommendations upon practical results over extended areas, has recently come out most emphatically in favor of one spray, claiming that this, if timely and thorough, will result in crops practically immune from codling moth injury.

It may be well to note in passing that Sanderson ['08] as a result of his extensive series of experiments, came to the conclusion that an early spray applied shortly after the blossoms fell, and another approximately three to four weeks later, at the time the codling moth eggs hatch, gave a maximum protection, though he admits that the value of the second application is doubtful when not over 50% of the fruit is likely to be infested or unless a rain follows the first treatment. Obviously, the

great advantage of the early application is that it enables the fruit grower to put the poison where a very large proportion of codling moth larvae will find it before they enter the apple, since about 67% attack the fruit at the blossom end. A second spraying made within a week or 10 days after the blossoms fall, simply makes a more thorough job and is a tacit admission that it is impossible to cover a tree well with one application. The third spraying, namely, when the young apple worms commence their feeding, justifies itself only when conditions have prevented an early application or possible thoroughness in the preceding sprays, is admissible when a poison has been used which may have been washed from the foliage by rains, or may be advised for very badly infested orchards.

With the data at present available we see no reason for urging treatment at the time the second brood of apple worms appear, since if the earlier spraying is thorough there is practically no second brood to be controlled. There are some observations worthy of note in this connection. Lloyd ['07] obtained data showing that Illinois apple stems might be injured even by a spray for the second brood containing but ¼ pound of paris green to 50 gallons of water. The damage was often greatest at the point of attachment of the stem and apple, both being injured. He gives data showing that before this stem injury, nearly all the windfalls were wormy, while subsequently a considerable proportion (18 to over 90%) were uninjured by worms. In spite of this excessive dropping, the crop on the sprayed trees averaged greater than that upon the check trees. Furthermore, he ascertained by careful study that this late application, even when applied after the small apple worms had entered the fruit, resulted in the destruction of many, due to their feeding for a time just under the skin. It is possible that some of those destroyed in this manner were the larvae of the lesser apple worm.

There is little or nothing in the experiments conducted in the East to justify the contention of our Western friends, to the effect that markedly superior results may be obtained by the use of a coarse spray driven by an exceptionally high pressure. We would select a nozzle giving the most uniform and rapid distribution of spray without regard to penetration. We would not be understood as discouraging the employment of high pressure, since this is undoubtedly an important factor in thorough and rapid work, the latter being extremely desirable on account of the limited time when successful applications may

be made. We are thoroughly satisfied that most excellent results can be obtained where conditions permit the use of only moderate pressures. The best time to spray is within a week or 10 days after the blossoms drop and while the green calyx lobes are open [pl 15, fig. 1].

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Hickory leaf stem borer

Acrobasis feltella Dyar[1]

This new species was reared in early July from caterpillars inhabiting hickory stems collected by Mrs A. M. A. Jackson, Warner, Onondaga co., N. Y. This borer, it was stated, was somewhat abundant upon young hickories. It was at first supposed to be identical with Acrobasis angusella Grote, a species also occurring in hickory leaf stems. Dr Dyar states that the adult is separated therefrom by the "conspicuous character of the inner pale band."

Life history. The larva of this new form bores in the interior of the leaf stem, causing a distinct enlargement an inch or more in length and 3/8 inch in diameter. This portion of the stem is eaten so that only thin walls remain, the cavity having a distinct orifice at one extremity and the latter usually connected with a rather extensive, white, frass-filled web an inch to 2 inches long and fastening several leaves together. The larval feeding appears to be confined almost entirely to the interior of the stem. Nothing further is known concerning the habits of this species though it is presumable that there is but one generation annually.

Description. *Larva.* Length 5/8 inch. Head dull amber, the thoracic shield greenish amber, the body nearly smooth, dull greenish or yellowish green, the dorsal vessel being indicated by a dark green stripe. Anal shield dark green, with a few sparse fuscous setae. True legs black. Venter and thorax a little lighter than the dorsum. First thoracic segment with a large lateral tubercle, second thoracic segment with a large, black, sublateral tubercle on either side and with the annulations rather deep.

[1] Dyar, H. G. Ent. Soc. Wash. Proc. 1909. 11:214.

Imago. The adult has been described by Dr Dyar as follows:

Forewing of male with a small patch of black scales beneath subcostally. Wings dark gray, the inner band beyond the subbasal patch of raised scales very broad, creamy white, shading to orange below, especially wide in its lower part. In the male the basal space and all of the thorax are white; in the female, these parts are gray. Discal dots joined. Outer line wavy crenulate, defined by an outward creamy shade. Hind wing light at the base in the male, entirely fuscous in the female. Expanse, 14–17 millimeters.

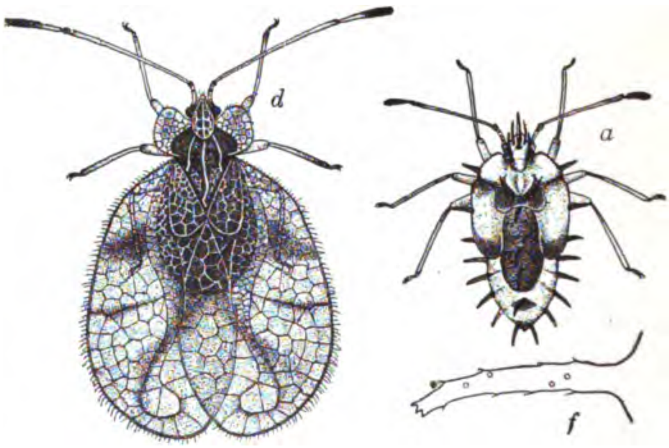

Fig. 1 Rhododendron lace bug: *a* nymph; *d* adult; *f* spine enlarged (after Heidemann)

Rhododendron lace bug

Leptobyrsa explanata Heid.

The delicate, lace-winged bugs excite the admiration of all close observers on account of their exquisite sculpturing. This species is no exception to the rule though on account of its rather serious injuries to Rhododendrons in the vicinity of New York city and also at Rochester, it has been the occasion of considerable complaint. The curiously spined young occur on the underside of the leaves during May and June, while the strikingly marked adults may be seen in early July. This species draws the sap from the underside of the leaf tissues, producing unsightly brown spotting accompanied by more or less serious injury to the foliage. Furthermore, the deposit of the eggs in the leaf tissues is an additional source of injury.

Description. The perfect insect is about ⅛ of an inch long, its delicately sculptured wings [fig. 1*d*] with sharply defined, transverse, brown marks near the middle being characteristic. The young

nymphs are rather long legged and ornamented with conspicuous tapering spines [fig. 1*f*]. This species has been described in detail by Mr Heidemann as follows:

Adult. Body short, oval in the female, more elongate in the male, shining black; membranous parts of pronotum and integument of elytra pale yellowish, semitranslucent, nervures yellowish. Head rather small, black, with three white frontal spines, two approaching each other, the middle one comparatively stouter; besides, there are two other more slender spines extending from behind the eyes towards front. Antennae long, finely pilose, yellowish, the tips infuscated; two basal joints slightly thicker than the following ones, first joint twice the length of second, third a little more than three times as long as fourth. Bucculae yellowish, narrow, angulate and broader behind, the edge upturned a little. Pronotum transverse, feebly convex, coarsely punctured, and shining black; in fresh specimens the sides of pronotum are covered with a whitish film that also extends toward the underside at the sternum. Hood not much inflated, cristate and slightly tapering towards front; covering the head, except the eyes, with quite large areoles at the sides near top and a few smaller ones at lower part. The three pronotal carinae yellowish, the median one strongly foliaceous, as high as crest of hood, rounded on top and slowly declining towards apex of the triangular posterior portion of pronotum, with a row of long, large areoles of which the middle ones are divided by a few cross nervures and embrowned; outer carinae very low, only half as long as the median carina, extending from base of hood to sides of pronotal portion posteriorly; the triangular part of pronotum rather short, yellowish and finely reticulated; membranous pronotal margins strongly rounded behind, reflexed, widening moderately at sides, narrowing toward the neck and reaching the lower part of hood close to the eyes, with two or three rows of average-sized areoles. Elytra ovate, iridescent, extending one half their length beyond abdomen, a little less in the male; strongly rounded from base to apex, broadest behind the middle; discoidal area pyriform and short, angularly raised at the outer nervure, somewhat rounded at apex and broadly scooped out on the upper surface, with three or four rows of quite large areoles at the widest part. Subcostal area subvertical, wider than the discoidal area, having about five rows of irregular small areoles, those of the upper row much larger; costal area broadly expanded, with four or five rows of very large, more or less irregular areoles, diminishing to three and two rows at base. Surface of elytra very peculiarly undulated, with two transverse, sharp impressions, and another at apex formed by the outer nervure of subcostal area; a light transverse fascia on basal half. Median nervure of subcostal area strongly sinuate towards tip of elytra; sutural area at inner part irregularly reticulated with rows of some extremely large areoles. Entire margin of elytra, lateral margins of pronotum, crest of hood, carinae, and most of the nervures beset closely with

long, very fine hairs. Rostral groove uninterrupted, broad at mesosternum and metasternum, angularly closed in front; rostrum reaching metasternum. Abdomen of female broadly rounded at apex, in the male more elongate, the sides of genital segment sinuated; at tip two strong claspers. Length 3.6 millimeters; width of each elytron across widest part, 1.4 millimeters.

Last nymphal stage. Body elongate elliptical, yellowish white, pellucid, some brownish spots on inner side of the wing pads basally and at apex; abdominal segments on the middle and all the appendages or processes toward the tip brownish. Pronotum transverse, lateral margins rounded; hood, median carina, and triangular posterior part of pronotum already indicated. Antennae as long as the whole body, finely pilose, yellowish, tip of the two terminal joints brownish. Wing pads reaching the third abdominal segment. Head with five long processes, of which two at base of head are most prominent and bent forward; two smaller ones on a little elevation of median carina near together; very large processes on each lateral margin of pronotum; two on the mesonotum and a single one at middle of the first, third, fourth, and sixth dorsal segments of abdomen; another on each wing pad; the processes on the lateral margins of abdomen are slightly smaller. These appendages or processes are peculiarly shaped, cylindrical, narrowing toward the apex, the edge of tip armed with two or three small sharp teeth; there are also some pores and short bristles on the surface of these processes visible by high power magnification. Length, 2 millimeters.

Egg. This, according to Heidemann, is cylindric, oval, yellowish white and about .4 millimeters long.

Life history. This species, according to Mr Heidemann, winters in eggs deposited in the epidermis of the leaves, mostly at the sides of the main rib. The eggs hatch probably early in May in this latitude, the recently emerged young being whitish, somewhat transparent and without spines. Later the color becomes greenish white and the antennae extend nearly to the end of the abdomen. In about four days the skin is shed and lateral processes begin to appear which become more apparent in subsequent molts. The partly grown nymphs may be observed on the underside of the leaves from then to early July at which time the insects become full grown.

Food plants and distribution. This species is recorded by Heidemann as quite abundant on Mountain Laurel, Kalmia latifolia and on the Great Laurel, Rhododendron maximum, and occurs along the Atlantic slope from North Carolina northward at least to New York State.

Remedial measures. Experiments with an allied form on asters several years ago demonstrated the feasibility of controlling that species with a whale oil soap solution, 1 pound to 9 gallons of water. Recent work shows that similar treatment with this or other contact insecticides is equally efficient in the case of this Rhododendron pest, provided the application be made to the underside of the foliage in May or early June.

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Plant lice

The season of 1909 was noteworthy because of the great abundance of plant lice. These tiny weaklings were extremely numerous on a variety of fruit trees, seriously affecting the foliage and in not a few instances exercising a very material influence on the development of the fruit. They were also present in unusual force on many other plants, such as currants, cabbage, hops, shade and ornamental trees and shrubs. The foliage was not only badly deformed, thickly smeared with honeydew and then discolored by the sooty fungus growing in this favorable medium, but the excretion was so abundant in many places as to keep sidewalks wet and sticky even on the hottest days.

Small or "aphis" apples

Aside from injury to foliage, there were many complaints on account of the numerous small apples. This latter was probably brought about by the plant lice or aphids being so numerous as to reduce the vitality of the trees at the time the fruit was setting, to such an extent as to prevent the one or two early fertilized blossoms of each cluster securing a sufficient start to outstrip the others and thus result in a large proportion of the fruit dropping at the outset. Instead of the latter, a very desirable and normal outcome, so many blossoms set that the trees were unable in large measure to produce average sized fruit. There was, as a consequence, very many small apples and relatively few good sized to large, marketable fruit. The extent of this was strikingly illustrated on the experimental plots in the orchard of Mr W. H. Hart, Poughkeepsie. The fruit of over 250 experimental trees distributed throughout the orchard and therefore representative, when picked and carefully classified,

showed that in approximately 100,000 apples there were only 54,845 marketable fruit, many of these being rather small, while 41,982 apples were so small as to be practically unmarketable. This small fruit, popularly designated by many growers as "aphis apples," was easily recognized by its small size and frequently irregular shape. It was estimated by one of the fruit growers that in the vicinity of Poughkeepsie approximately 33% of the crop was thus affected though this figure may be somewhat high. Similar injury was very prevalent in orchards in the western part of the State.

Apple aphids

There are four species of plant lice or aphids very likely to occur on our fruit trees. The woolly apple aphis,[1] as is well known, restricts its attack mostly to the vicinity of wounds on trunk and branch and also occurs on the roots. It is rarely abundant enough in New York State to cause material injury. The other three species, known respectively as the European grain aphis, the green apple aphis and the rosy apple aphis, attack the foliage and will be discussed briefly below.

European grain aphis. (Siphocoryne avenae Fabr.). This European species has, until recently, in this country been considered identical with the green apple aphid, a species which has been known to occur in America for many years. This aphid is, judging from available records, probably very generally distributed throughout the United States. It has been recorded as occurring upon apple, pear, quince and plum, and such grains as rye, oats and wheat. This species passes the winter in its shiny, jet black eggs deposited by the females in the fall around the buds of the more terminal shoots, in crevices at the crotches of limbs and under scales of the bark. The eggs hatch about the time the young leaves appear, and the small, green plant lice begin to feed upon the unfolding foliage. These early individuals soon commence to produce living young, the latter shortly attain maturity, develop wings, fly to other trees and continue the process of multiplication. This species may be most easily recognized by the oval, yellowish green or brown body. Investigations have shown that there may be four or five generations in the latitude of Washington, and that by early July the trees are deserted for the grains, grasses or other host

1 Schizoneura lanigera Hausm.

plants. In the fall there is a return migration from the grasses and grains and the deposit of winter eggs as mentioned above.

Green apple aphis (*Aphis mali* Fabr.). This species, like the preceding, passes the winter as black eggs which are undistinguishable from the above noticed form. The plant louse has a pear-shaped, yellowish green, green or dark green body instead of the oval form of the European grain aphid. The eggs of this widely distributed form hatch a little later in the season, and the plant lice, like the preceding, frequently cause serious curling of the foliage. This plant louse occurs upon the trees throughout the season and, under conditions obtaining in New Jersey, may produce six generations before the appearance of the sexual forms and the deposition of eggs destined to hatch the following season.

Rosy apple aphis (*Aphis malifoliae* Fitch). This species is easily distinguished from the preceding by its larger size, rounder shape and usually rosy color, though this latter may vary from salmon to tan or even to slaty gray or black, the body being dusted with whitish. This widely distributed aphid, like the preceding, winters as eggs deposited on the trunk and larger limbs. The young plant lice appear with the unfolding of the leaves. There are about three generations produced before the trees are deserted for an unknown food plant. There is a return migration in the fall and the deposition of eggs.

Certain other aphid pests

Cherry aphis (*Myzus cerasi* Fabr.). This species is more or less abundant every year and, like some of its allies, was excessively numerous the past season. It is easily recognized as the black aphis so prevalent in early summer on sweet cherry foliage, portions of the leaves sometimes being nearly black with insects. Occasionally the attack is so severe as to result in the entire destruction of the leaves for a foot or 2 feet from the tips of the shoots. Such an outbreak means serious injury to the trees.

Hop aphis (*Phorodon humuli* Schrk.). The hop louse was locally abundant and is occasionally quite injurious to this plant. It is one of the forms known to have two food plants. The winter is passed as small, glossy, black eggs on various species of Prunus or plum, both wild and cultivated. The eggs hatch in early spring and three generations are produced on the

plum prior to the flight in June to the hop vines. There have been, according to careful and extended investigations conducted under the supervision of the late C. V. Riley, at that time entomologist of the federal government, 4 to 12 generations, depending upon weather and other conditions. Winged adults, produced at the end of the season, migrate back to the plum and deposit the black eggs which remain unhatched till the following spring. This peculiarity in the life history of the hop aphis, suggests the desirability of eliminating useless wild and domestic plums in the vicinity of hop yards, and also the wisdom of spraying other plum trees in the spring for the purpose of destroying the plant lice before they have had an opportunity of migrating to the hop.

Corn root aphis (Aphis maidiradicis Forbes). A subterranean species such as this, is very likely to escape notice and this is probably the reason why it is rarely brought to attention in New York State, though it is well known as a corn pest in the Central States. Examples of this species, kindly identified by Mr Pergande, through the courtesy of Dr Howard, were received under date of September 29 from Mrs H. Reineck of Albany, with the statement that she experienced difficulty in raising asters, owing to the abundance of plant lice upon the roots. Specimens submitted for examination showed the roots to be thickly clustered with small, bluish green or reddish brown, wingless plant lice about 1 millimeter long. Young aphids were also observed feeding upon the rootlets. These pests were apparently attended by ants, the latter probably excavating the soil around the roots and possibly constructing chambers in which the plant lice could winter more successfully. Injury by this species in New York State appears to be so rare that, generally speaking, remedial measures may be considered inadvisable. It might be well in case of an infestation in the garden, to pull the plants in late fall and thus destroy in large measure the hibernating quarters of the aphids. Should this not be feasible, many of these plant lice could be destroyed by treating the ground with carbon bisulfid.

Norway maple aphis (Chaitophorus aceris Linn.). This large, yellowish green, brown marked plant louse with long, hairy antennae and reddish eyes is frequently abundant throughout the greater part of the season on the underside of the leaves of Norway maples, and is remarkable for the large

amount of honeydew excreted. The latter occasionally collects in rather thick, viscid masses on the foliage, and not infrequently is so abundant as to keep the sidewalk beneath infested trees wet even in hot summer weather. This insect was excessively numerous in many sections of the State in 1909, seriously injuring the foliage of many beautiful trees and in not a few instances causing 10 to 25% of the leaves to drop. In very severe attacks practically all of the leaves may be seriously affected and a considerable proportion drop before others have an opportunity to develop. This species is usually controlled in midsummer by natural enemies, the beneficial ladybeetles or ladybugs being among the most active.

Painted maple aphis (Drepanaphis acerifolii Thos.). This beautiful little plant louse was very abundant and rather injurious to soft maples in particular, though it occurs in small numbers on the hard or sugar maple. It is easily recognized as a small, red eyed, black and white marked plant louse with prettily marked brown wings. The young are pale yellowish and wingless.

Box elder aphis (Chaitophorus negundinis Thom.). This gregarious species has been somewhat abundant the last few years on the relatively few box elders observed in the vicinity of Albany, N. Y. It is a greenish form, the abdomen being pale green, the head brown, the latter and the prothorax both hairy.

Elm leaf aphis (Callipterus ulmifolii Mon.). This very slight, inconspicuous, pale greenish plant louse was excessively abundant on the underside of American elm leaves, causing serious injuries, especially in the western and southern portions of the State. It was so numerous at Dunkirk and Fulton as to cause considerable annoyance on account of the large amount of honeydew dropping from the trees.

Woolly elm aphis (Schizoneura ulmi Linn.). The woolly elm aphis is easily recognized in June by the badly curled leaves of white elm, usually accompanied by the dropping of wax-powdered pellets of honeydew. This species is sometimes excessively abundant on elm foliage, the affected leaves curling so as to form a cavity which may be brimful of struggling plant lice and particles of whitish honeydew. Professor Gillette is inclined to believe that the woolly aphid, occurring on the bark of elm and known as Schizoneura rileyi Thos., is identical with this form.

Woolly beech leaf aphis (Phyllaphis fagi Linn.). This rather inconspicuous plant louse, occurring on the underside of beech leaves, is most easily recognized by its woolly covering. It has been abundant on purple beeches in Washington park, Albany, N. Y., for the past decade, occasionally becoming very numerous, as was the case in 1909, though never causing perceptible curling of the foliage. A dying, small tree observed had the leaves nearly destroyed by this plant louse.

Woolly larch aphis (Chermes strobilobius Kalt.). This species continues abundant upon larches in Washington park, Albany, N. Y., though it is not especially injurious. The winter is passed in the egg state, over 200 having been counted in an egg mass of moderate size. The young appear in early May and settle on larch needles, at which time they somewhat resemble grains of black gunpowder. They increase in size and in the course of a few weeks, excrete an abundance of white, woolly matter, giving a very characteristic appearance to infested trees.

Pine bark aphis (Chermes pinicorticis Fitch). This species continues abundant on pines in Washington park, Albany, N. Y., and is probably responsible in large measure for the gradual destruction of two groups of young pines, individual trees of which have died from time to time during the past decade. This insect winters as yellowish brown eggs, well protected by the copious, waxy secretion, young appearing in the latitude of Albany, N. Y., from the middle to the latter part of May. The full-grown female is a dark grayish purple and about 1/32 of an inch long. This species has been the occasion of complaint from several sections of the State and has also proved to be a pest on seedling pines in forest nurseries. Attack by this plant louse is very likely to be followed or accompanied by bark borer injury. It has also been observed on balsam. This species is particularly subject to attack by ladybeetles.

Woolly pine aphis (Schizoneura pinicola Thos.). This species, kindly identified by Mr Pergande, through the courtesy of Dr L. O. Howard, was brought to notice by State Forester C. R. Pettis in October on account of its abundance on the roots of seedling pines grown in forest nurseries at Lake Clear Junction, N. Y. The plant lice, he stated, were very abundant upon the roots. Samples submitted for examination

showed that there had been considerable colonies several inches below the surface, the infested points being marked by an abundance of woolly, waxy matter and in some instances there was considerable exudation from the roots, possibly as a result of the injuries inflicted by this plant louse. Mr Pettis, writing under date of October 10, states that the plant lice appear to live in the ground at night but with the appearance of the sun they emerge and fly, the phenomena he observed probably being the normal autumnal flight. The trees affected were all native pines and so far as a superficial examination went, appeared to be in excellent condition.

Gall-making aphids

There are a number of species of plant lice particularly interesting because of the vegetable deformations, more generally termed galls, which they produce. Ordinarily these gall-making species are not very injurious though their effects upon plants are frequently somewhat conspicuous.

Cockscomb elm gall (Colopha ulmicola Fitch). The gall made by this species, on elm foliage, is very common and is easily recognized by the long, irregular, frequently red tipped cockscomb swellings running parallel with the veins and sometimes so abundant as to seriously deform the leaves. Occasionally small trees may bear one or more galls upon almost every leaf, while the foliage of individual branches on larger trees may be badly malformed because of these abnormal growths. The young galls appear about the first of May as slightly elevated ridges on the upper side of the leaf. Soon after, on the opposite surface an elongate opening is seen, and on pulling the walls apart the glossy, olive-brown plant louse is disclosed within the cavity. This is the parent louse. Four or five weeks later or during the month of June the interior of the gall will be found occupied by numerous young grouped around the mother. Within the gall, among its many occupants, are numerous glistening globules of a sweet liquid or honeydew excreted by the plant lice. Later the opening into the gall spreads apart and the insects are thus free to escape. The species is said to winter as eggs deposited in sheltered places on the bark.

Spiny hazel gall (Hamamelistes spinosus Shim.). This peculiar form, as determined by the recent investigations of Mr Pergande, has an extremely interesting life history, occur-

ring as it does, in oval, spiny bud galls on witch-hazel and upon the leaves of birch. The season of 1909 was remarkable on account of the abundance of this species upon birch foliage, both in the vicinity of Albany and Hudson and probably in other portions of the State. The plant lice were so numerous as to cover the foliage with honeydew, which was soon followed by the development of the sooty fungus and the resultant blackening of the leaves. A summary account of this plant louse, accompanied by illustrations, has been given by the writer.[1]

Witch-hazel cone gall (Hormaphis hamamelidis Fitch). The conical, green or reddish galls of this plant louse are more or less abundant upon witch-hazel leaves from year to year and occasionally extremely numerous. This, like the preceding form, migrates to the birches and also has a varied and extremely interesting life cycle, which latter has also been summarized by the writer.[2]

Hickory gall aphid (Phylloxera caryaecaulis Fitch). This is one of the commonest of our Phylloxera galls on hickory and presumably the most destructive, though some other species are occasionally very abundant and undoubtedly seriously affect the trees. The young galls of this species occur in early June, at which time they vary from the size of a pea to that of a small marble and range in color from pale greenish to a bright pink. They are irregularly spheroid, being usually prolonged at the union with the midrib or petiole and with a more or less distinct, somewhat irregular, ventral orifice which is completely closed. Many of the galls are so near each other that they fuse. Each contains a central cavity with its stem mother and numerous young plant lice. Later the galls become green or rosy and as they increase in size the plant lice multiply to such an extent that during the latter part of the period of growth, the inner surface of the gall may be literally covered with numerous young, pale green plant lice. Finally, the distorted tissues die, turn black and leave an ugly, shrunken mass. This is only one of a number of species of Phylloxera likely to occur upon hickory. Mr Pergande, who has made an extended study[3] of the species occurring upon hickory, divides

[1] N. Y. State Mus. Mem. 8, 2:643.

[2] N. Y. State Mus. Mem. 8, 2:639.

[3] N. Amer. Phylloxerinae Affecting Hicoria (Carya) and Other Trees. Davenport Acad. Sci. Proc. 1901. 8:185–273.

the galls into three groups. The thin, paperlike or more or less transparent ones occurring upon leaves, the thicker, fleshy, variform galls always opening beneath and on leaves, those forming elongate folds along the veins, and finally, a fourth class represented by the species discussed above, producing galls on the twigs or leaf petioles. Phylloxera galls on hickory leaves are frequently very numerous and are produced by a number of species, though the leaf inhabiting species are rarely abundant enough to cause material injury. The Phylloxera galls usually have a distinct orifice and may be distinguished from similarly appearing Cecidomyiid galls by the minute plant lice within.

Red elm leaf gall (Pemphigus ulmifusus Walsh). The large, solitary, spindle-shaped galls about 1 inch long, produced by this plant louse, occur on the upper surface of the leaves of red elm. The interior, as in the case of other plant louse galls, is frequently swarming with aphids in various stages of development. This species is somewhat rare in New York State.

Vagabond gall (Pemphigus vagabundus Walsh). This insect produces a rather common leafy deformation. It is simply a peculiar, folded, convolute mass of foliage some 2 inches in diameter and near the tips of the twigs. Occasionally these galls are quite abundant.

Poplar leaf stem gall (Pemphigus populitransversus Riley). This species is sometimes very abundant. The galls are oval, about ½ inch long, somewhat elongate, with transverse openings, and develop near the middle of the leaf petioles of cottonwood during the latter part of the summer. The poplar is also affected by several allied forms.

Spruce gall aphid (Chermes abietis Linn.). The presence of this insect is easily recognized by the cone-shaped, many celled galls formed at the bases of young spruce shoots. These dry, turn brown and open in August, thus allowing the inclosed plant lice to escape. This insect is widely distributed in New York State and has been responsible in recent years for a number of inquiries accompanied by complaints of injury. This latter is due in large measure to the inability of the affected shoot to continue its growth and, as a consequence, the branches soon become irregular and the tree very unsightly.

Honey and honeydew

The superabundance of plant lice was not without its effect upon the apiarist and his products. Honeydew was so abundant that the bees gathered it very largely and in some localities produced a considerable quantity of honey which, under a strict interpretation of the Pure Food Law, could hardly be considered as pure honey, since the latter is held to be the modified nectar or natural sweets of the blossom and not a saccharine excretion from some other insect. Furthermore, the product elaborated from honeydew is not considered a desirable winter food for bees, though it can be safely employed in the spring for brood rearing.

Near the posterior extremity of most plant lice there is a pair of conspicuous processes very generally termed honey tubes, and by many supposed to be the organs from which the honeydew, so prevalent on aphid infested foliage, is produced. It is well known that drops of liquid may appear upon these organs, which might more properly be termed cornicles rather than honey tubes, since the latter designation is misleading, as is shown by the investigations of Professor Horvath, who states, according to an abstract prepared by Mr Bueno, that when "an ant strokes an aphis with its antennae a clear drop appears always at the end of the abdomen whilst the cornicles excrete nothing. On the other hand, if an aphis be picked up in the fingers, or if it be touched with a straw, a tiny drop at once appears at one or both cornicles which is always colored." Honeydew must thus be regarded as a waste product of the body rather than as a highly elaborated secretion. Dr Horvath concludes that the "cornicles of the aphids are the excretory canals of wax-producing glands differentiated in a special manner and the product of which is a means of defense against the Coccinellidae and the Chrysopidae."

Climate and plant lice

It is evident to even the most casual observer, that delicate, nearly helpless insects like plant lice, feeding almost unprotected upon the foliage of various trees, must be more or less susceptible to climatic conditions. This is well substantiated by the behavior of various species. The remarkable abundance of these small insects the past year was comparable only with the outbreaks of 1897 and 1903, years distinguished by the superabundance of these pests. Observation and weather records show a distinct correlation between a low, unseasonable tem-

perature and the multiplication of plant lice. The past summer was remarkably cool and backward, a marked change for the better occurring June 21. That the earlier cool weather was favorable to the plant lice, was evidenced by the hosts occurring upon the leaves of many trees. The reason is probably found in the fact that the unusually low temperature prevented the normal activity of such natural enemies as ladybeetles, flower flies and minute 4-winged parasites. Prior to the appearance of warm weather numerous lots of plant lice, showing no evidence of having been materially injured by natural enemies of one kind or another, were received. Shortly after the rise in temperature a very different condition of affairs obtained. Leaves injured by plant lice continued to be received, but in almost every case a few natural enemies had begun to reduce the numbers of the pests, or especially toward the end of the outbreak, most had been destroyed and the leaves only bore evidence of earlier injury. Recent observations on the spring grain aphis in the Southern and Middle States have shown a similar correlation between temperature and the development of plant lice and their enemies.

The obvious lesson to be drawn from the above is that plant lice outbreaks may be expected when the late spring weather is unusually cool and backward, unless it is accompanied by pelting rains which are undoubtedly of considerable service in destroying exposed aphids. The advisability of adopting direct repressive measures in specific instances, must depend in large measure upon the probability of warmer weather developing soon enough so that natural enemies may check the aphids before material injury is caused.

Ants and aphids

There is a somewhat intimate relation existing between ants and aphids. The former appreciate the sweet excretions of the latter and not infrequently protect and even construct shelters for various species of plant lice. The popular characterization of aphids as the milch cows of ants, expresses fairly correctly the relationship which may exist between such divergent forms, though possibly it implies too much interdependence on the part of both. Ants can subsist without the secretions of plant lice; and conversely, protection by ants is not necessary to the existence of aphids. There are well recognized cases where ants

are potent factors in increasing the destructiveness of aphids. One of the best known is the case of the corn root aphid[1] and the corn field ant.[2] This ant colonizes the aphid in cultivated fields, on the roots of weeds and corn, and materially increases its destructiveness. The casual nature of this relationship is exhibited by the observations in Louisiana, of Prof. Wilmon Newell on the recently introduced Argentine ant, I r i d o m y r m e x h u m i l i s Mayr. and native plant lice which are colonized by this species and, as a consequence, the latter are decidedly more injurious in sections where the Argentine ant is abundant.

Natural enemies

The almost helpless plant lice are subject to attack by a number of insect enemies. The beneficial ladybeetles or ladybugs, easily recognized, as a rule, by their red color and conspicuous black dots, are among the most serviceable of these natural enemies. They, in association with their ugly, black grubs, are frequently found on badly infested trees, feeding voraciously and destroying hordes of these pests. The 2-spotted ladybeetle[3] is one of the more common of these forms, though the ocellate or 15-spotted ladybeetle[4] is frequently found in numbers, especially on shade trees. Another common form is the 9-spotted ladybeetle.[5]

The important part played by the delicate, handsome flower or syrphid flies, should not be overlooked. These insects are usually brightly marked with yellowish and brown, generally with conspicuous, reddish eyes and may frequently be seen hovering in bright sunlight. They deposit their delicately sculptured eggs in colonies of the plant lice, and the greenish or yellowish, sometimes red marked, varicolored maggots, less than half an inch long, devour hosts of aphids before they attain maturity. These active enemies of plant lice are easily distinguished from all other species found in such situations, by the body gradually enlarging from the head backwards. The maggots seize individual plant lice, raise them from the leaf and quickly drain the body of its vital fluids.

[1] A p h i s m a i d i r a d i c i s Forbes.
[2] L a s i u s n i g e r a m e r i c a n u s.
[3] A d a l i a b i p u n c t a t a Linn.
[4] A n a t i s o c e l l a t a Linn.
[5] C o c c i n e l l a n o v e m - n o t a t a Hbst.

There are a number of tiny, 4-winged, parasitic wasps which subsist entirely on plant lice. These beneficial insects deposit their eggs in their victims, one in each, and the maggots develop rapidly at the expense of the host. The infested aphids are easily recognized by the greatly swollen, frequently globular and usually brown abdomen. Occasionally a very large proportion of the many plant lice on individual branches, or even entire shrubs or trees, are affected in this manner. Each plant louse perishes, while the maggot within, before completing its transformations, fastens the body of its host to the plant. The parasite itself, as it escapes, cuts a characteristic, circular orifice, leaving the central portion or lid attached by a narrow hinge. It is therefore very easy to estimate the proportion of plant lice destroyed by these parasites.

In addition to the above, the voracious larvae of the extremely delicate, lace-winged flies, destroy hosts of aphids. The golden eyed parent insects are usually light green and easily distinguished by the large wings adorned with numerous minutely spined veins. They deposit their oval, whitish eggs in picturesque groups on leaves or twigs, each egg supported by a slender, threadlike stem nearly an inch long. The larvae are rather flattened, 6-legged creatures, usually variably marked with brown and yellow, and remarkable because of the greatly produced jaws. Plant lice and other small insects are seized in these enormous jaws and quickly perish as the body juices are drawn through the hollow cavities of the mandibles.

Remedial measures

The experience of the last few years has demonstrated the futility of depending upon the ordinary winter or early spring applications of lime-sulfur washes for the destruction of aphid eggs upon our fruit trees. There may be some reduction but the percentage killed in this manner is so small as to be practically negligible.

Most fruit growers are thoroughly familiar with the curling leaves quickly following plant lice outbreaks, and appreciate the difficulty of destroying the insects after the attack has progressed thus far, owing to the impossibility of hitting the plant lice with any contact insecticide. Experience has demonstrated time and again, the practicability of destroying these minute enemies of our plants, by thorough applications of con-

tact insecticides, such as tobacco preparations, whale oil soap solutions, kerosene emulsions or even dilute preparations of some of the commercial petroleum compounds now on the market under various trade names.

Tobacco preparations of various kinds have long been used for the destruction of plant lice, though some experience is necessary to secure the proper dilution, owing to the variability of waste tobacco products from which decoctions are usually prepared. There are now on the market a number of ready-made tobacco extracts. A most promising one is known as black leaf extract. It has given very good results in an experimental way, even when diluted with 60 parts of water.

The experience of the last season or two has also demonstrated the feasibility of employing a dilute lime-sulfur wash. Several practical orchardists have used the better grades of commercial lime-sulfur washes, diluted with 40 parts of water and adding thereto two pounds of lead arsenate to each 50 gallons, making the application at the proper time for controlling codling moth. It has been found effective, so far as the last named pest is concerned, extremely serviceable in destroying plant lice and of great value as a fungicide. It is possible that this combination or some modification may ultimately take the place of the poisoned bordeaux mixture and solve for all time the problem of controlling plant lice outbreaks, since one thorough spraying with a contact insecticide just after the blossoms fall, would probably obviate the necessity of any further treatment for plant lice, particularly if this was an annual practice.

The insecticide to be employed must depend somewhat upon conditions. There is no doubt but that a thorough application of a whale oil soap solution, used at the rate of one pound to six or seven gallons of water, is very effective. Even a strong suds of ivory soap, approximately a five cent cake to eight gallons of water, is extremely serviceable and may be employed upon a large variety of plants without injury. The standard kerosene emulsion, diluted with 9 to 15 or more parts of water, is equally valuable. Ready-made oil emulsions, requiring dilution only before application, are on the market and are much more convenient for the small fruit grower.

The essential in all these cases, so far as plant lice are concerned, is to make the application before the foliage has be-

come badly curled. The need of special treatment for aphis outbreaks. must, of necessity, depend upon several factors, namely, favorable weather conditions and the relative abundance of natural enemies. It has been shown above that abnormally cool weather in the spring and early summer is likely to be followed by aphid outbreaks, owing to the fact that plant lice reproduce readily under such conditions, while the activities of their natural enemies are seriously hindered. Consequently, an incipient attack by plant lice, accompanied by a scarcity of natural enemies and the probability of continued cool weather, should serve as a warning to the fruit grower and result in immediate spraying.

NOTES FOR THE YEAR

The following are brief notices of some of the more injurious species which have come to attention from time to time throughout the season.

Fruit tree pests

Fruit tree bark beetle (Eccoptogaster rugulosus Ratz.). This insect is more or less prevalent from year to year and is best known on account of its injuries to plum and peach. The past season the writer found a large apple tree in the orchard of William Page of Bethany, N. Y. which had evidently been killed by this insect. It may possibly have been in an unhealthy condition prior to the attack though the numerous galleries of the borers on practically all of the smaller limbs give unquestioned evidence that this species was the initial cause of the trouble. The operations of this pest were also observed in a young pear orchard at North Rose, one small tree having been killed in early August this season and others exhibiting more or less evidence of serious injury.

Canker worms. These voracious leaf feeders have been allowed to continue their devastations in the southeastern portion of New York State in particular. Hundreds of apple trees in Port Chester and northward were practically stripped of leaves the past season and from the appearance of the trees one might infer that this condition had prevailed for a number of years past. These common pests, easily controlled by timely applications of an arsenical poison or by the employment of sticky bands, have been noticed innumerable times. A summary discussion of these insects and methods of controlling them is

given in the writer's report for 1908 [N. Y. State Mus. Bul. 134, p. 45-47].

Tarnished plant bug (Lygus pratensis Linn.). Almost every year we receive inquiries as to the cause of deformed apples. These can not be answered satisfactorily in all cases, though recent investigations indicate that in the above named species we have one of the offenders in this respect. The tarnished plant bug is a small, yellowish and black, angular insect about ¼ of an inch long. It occurs on a considerable variety of plants. The investigations of Dr Taylor in Missouri have shown that this familiar species may deposit eggs under the skin of young apples. The injured portion heals with the formation of corky tissue and fails to grow. Thus, as the apple develops, an unsightly, craterlike depression is produced, materially affecting the value of the fruit. There is no practical method of controlling this pest, aside from keeping the orchard and its surroundings as free from brush, coarse weeds and other shelter as possible.

Rose leaf hopper (Typhlocyba rosae Harr.). This species was found October 2, 1909 in considerable numbers on the young apple trees of Mr George T. Powell, Ghent, N. Y. The foliage was badly specked by this insect, in some instances the damage almost approximating the injury inflicted by the grape leaf hopper, Typhlocyba comes Say in the Chautauqua region. There was every indication that the insects had bred in considerable numbers upon the apple, particularly toward the latter part of the season, since cast skins were rather numerous on the foliage. Rose bushes were certainly not abundant in the vicinity. This attack though unusual, is not unprecedented, since the late C. V. Riley recorded this species as abundant on apple foliage at Burlington, Vt., in 1892, while Prof. G. C. Davis, according to Professor Gillette took specimens at the Michigan Agricultural College on the foliage of apple, plum, tame cherry, currant and grape. This species, should it become abundant, can be easily controlled by the application of a contact insecticide before the leaf hoppers attain maturity and are therefore able to fly.

San Jose scale (Aspidiotus perniciosus Comst.). This pest, while not attracting such widespread notice as in earlier years, has continued to multiply and is slowly becoming established in sections previously uninfested. A large number of fruit trees in the Hudson valley have been seriously injured or destroyed by

this scale insect in recent years. These injuries or losses have almost invariably followed neglect, intentional or otherwise. The experience of another season has but served to confirm the findings of earlier years and emphasize the importance of a lime-sulfur wash in checking this pest. Some practical fruit growers have been able to obtain such excellent results that their neighbors have raised the question as to whether the pest was really present. Such gratifying results have not only been obtained with the ordinary homemade lime-sulfur wash, but also with some of the commercial preparations for sale in this State. The latter appeal very strongly to some fruit growers, since they only require dilution prior to application. The Cordley lime-sulfur wash, a formula which calls for approximately twice as much sulfur as lime, has been used in several places with great satisfaction, particularly as it can be made up in large quantities and held indefinitely without danger of the sulfides crystalizing. A dilution of the commercial lime-sulfur wash is also being used as a summer spray with excellent results though we would remind growers that sufficient time has not elapsed, since this method of application has been used, to permit of exhaustive tests.

An investigation of the orchard belonging to Mr W. H. Hart at Poughkeepsie, N. Y. shows that he had been able to control the San José scale in a most gratifying manner. Trees which five or six years ago were so seriously affected that perhaps a quarter of the tops had died and the indications were that the trees might be killed within a few years, are now in a most vigorous condition and well laden with fruit. This has been brought about largely by spraying with a lime-sulfur wash, the application being made entirely from the ground, since the uneven surface precludes the successful employment of towers. The badly affected trees noted above had the tops cut out some three or four years ago, in some instances limbs 3 inches in diameter being removed [pl. 20, 21]. There was some suckering following this operation, yet there has been a vigorous growth and a bounteous production of fruit. Careful observation is necessary to recognize the trees which have been treated in this way. Mr Hart experiences no difficulty in controlling the San José scale with a lime-sulfur wash, provided conditions allow two applications each spring with the wind in opposite directions. He finds a stiff breeze necessary to carry the spray throughout the entire tree. Much of the fruit in Mr Hart's orchard is practically free from San José scale, aside from occasional branches

which were inadvertently missed during the spraying operations. Last spring Mr Hart employed the Cordley lime-sulfur wash and proposes to boil, the coming November, sufficient material for the spring application of 1910.

West Indian peach scale (Aulacaspis pentagona Targ.). A small branch of Prunus pseudo-cerasus was received from New Rochelle through nursery inspector T. F. Niles accompanied by the statement that this scale insect had been observed by him for some years in the vicinity of New York city. The specimens examined came from a tree which had been set at least three and probably five years ago, presumably being imported from Japan. The portion of the limb submitted for examination was very badly infested, showing that the insect had apparently thrived in this climate though it was supposedly not hardy north of Washington, D. C.

Oyster scale (Lepidosaphes ulmi Linn.). This species, easily recognized by its brown, oyster shell shaped scale, some 1/8 of an inch long, continues to be abundant here and there, occasioning complaint on the part of the fruit grower and frequently causing serious injury to young trees. As has been previously noted, it displays a marked prolificacy on poplar. This pest may best be controlled by thorough spraying with a contact insecticide at the time the minute, yellowish young are crawling in numbers, namely, the latter part of May or early in June. Winter applications of a lime-sulfur wash have given good results in the hands of some and are worthy of further trial. The later the application can be made without injury to the tree, the better the prospects of satisfactory results following. This wash seems to prevent the establishment of the young rather than destroy the eggs.

Blister mite (Eriophyes pyri Nal.). This minute enemy of the fruit grower is becoming increasingly abundant in the Hudson valley, bad infestations having been reported to the writer from several Columbia county localities and also from Washingtonville. The general characteristics of the work of this pest and methods of controlling it have been given by the writer in his preceding report [N. Y. State Mus. Bul. 134, p. 48].

Small fruit insects

Grape blossom midge (Contarinia johnsoni Sling.). We were extremely fortunate in rearing this tiny midge last spring from material collected the preceding June. The parent insect is

a small, delicate, pale yellowish fly only about 1/25 of an inch long. The male can be recognized by the long, knobbed, hairy feelers or antennae one half longer than the body. The female is about 1/16 of an inch long and may be distinguished by the shorter, less densely haired feelers or antennae. The slender ovipositor, as long as the body in this sex, is well adapted to placing the tiny eggs within the developing floral tissues. Field observations June 15–17 showed that this midge was fully as abundant in the Chautauqua region as in 1908. The work of these insects in the vineyard of Mr H. L. Cumming of Fredonia resulted in the destruction of a considerable proportion of his Early Moore grapes, possibly over 75%. This midge not only causes serious loss by blasting numerous grapes in the bud, but inflicts damage by destroying a few grapes in many clusters, thus materially affecting the appearance of the bunches and lowering their commercial value. The youngest larvae found June 15 were probably but two or three days old, while many were fully half grown and would presumably desert the blossom buds within four days to a week. No midges were seen flying in the vineyard either in the afternoon or early evening. A close examination of cobwebs and windows in the near vicinity of the badly infested Early Moore vines resulted in finding no midges. Similar conditions obtained near somewhat badly infested Concord vines in the vineyard of D. K. Falvay at Westfield. The midges are apparently not attracted to any extent by light and probably remain near their food plants, as is the case with the violet midge, Contarinia violicola Coq. It is probable that the grape blossom midges fly in normal seasons about the first of June. An extended account accompanied by detailed descriptions of the larvae and both sexes is given in the writer's report for 1908 [N. Y. State Mus. Bul. 134, p. 15–19].

Tree crickets (Oecanthus sp.). These insects, though predaceous and therefore beneficial, have the unfortunate habit of depositing their eggs, which remain unhatched till the following spring, in woody tissues. A very large proportion of the raspberry canes in a patch near Albany were seriously injured last winter by this insect. Recent investigations conducted at the Agricultural Stations located at Geneva and Ithaca have shown that the snowy tree cricket, Oecanthus niveus DeG. is not, as has formerly been supposed, the chief offender in this respect. The snowy tree cricket usually deposits its eggs singly or in pairs in apple twigs. The studies of Professor Parrott show that this in-

jury is very likely to be followed by blight infection. The species thus far known to be responsible for the long series of egg punctures in raspberry, blackberry and other soft stemmed plants are the black horned tree cricket, Oecanthus nigricornis Walk. and the 4-spotted tree cricket, Oecanthus quadripunctatus Beutm. This injury is very likely to be followed by the cane splitting or even breaking during the winter and, in some instances, as many as three fourths of the canes in a large patch may be seriously injured. The tree crickets are most abundant among coarse weeds and shrubby growths, consequently, the adoption of clean cultural methods, so far as possible, will be of considerable service in reducing their numbers and preventing subsequent damage.

Miscellaneous

Say's blister beetle (Pomphopoea sayi Lec.). This large, usually rare blister beetle is nearly an inch long and is easily distinguished from allied forms by its rather stout, olive-green body and the shining black, orange banded legs. This species was quite abundant the latter part of June and early in July at Quaker Street, Schenectady co. and in the vicinity of Voorheesville, Albany co. In the first named locality it was said to be swarming upon roses and other plants, devouring much foliage and causing considerable injury, while at Voorheesville it destroyed many of the blossoms on locust trees and fears were entertained of serious injury to crops. It is interesting to note that our records show that this species was abundant in the same vicinity in 1900. This blister beetle usually disappears before material damage has been inflicted.

Army worm (Heliophila unipuncta Haw.). This widely known insect was very abundant on Long Island causing serious injury to wheat fields at Oakdale, while similar devastations were reported from Greenlawn, the Hamptons and Orient. This pest was abundant in limited localities at least, in southeastern Westchester county, as was evidenced by the writer finding July 2, numerous caterpillars on the estate of W. W. Cook at Port Chester. A nearby outbreak was also reported. This species attracts notice only when the hordes of caterpillars devour all of the foliage in the immediate vicinity and then begin to march as though by a common impulse in search of provender. A relatively insignificant factor may result in army worm depredations being observed. A few years ago the writer's attention was called to a strip of grass

land where hordes of the pest appeared, though none were observed on either side. The only difference that was known to exist between infested and uninfested territory was that the infested territory had a little earlier in the season suffered rather severely from a hailstorm. It is probable that the hail destroyed enough of the grass so that the caterpillars were compelled to seek food elsewhere, though under normal conditions they would not have attracted notice.

An army worm outbreak requires prompt treatment. Grass or grain in badly infested fields, if of any value, should be cut and removed at once and the migration or marching of the hungry caterpillars prevented by digging slight ditches or turning furrows toward the advancing horde. The ditches and furrows can be made more effective by digging small holes at intervals of 15 or 20 feet in which the caterpillars turning to either side, fall. They can then be readily destroyed by burying. Bands of tar are serviceable in checking the advance of the pests and may be made more effective by putting the tar upon boards and setting the latter on edge. Conditions occasionally warrant the poisoning of a strip in front of the marching caterpillars, in order to destroy them and prevent further injury. Paris green, london purple or even white arsenic is preferable for this purpose to the slower acting arsenate of lead. Masses of caterpillars can be killed by liberal spraying with a kerosene emulsion or a strong soap solution. Not infrequently these outbreaks are accompanied by the presence of numerous natural enemies such as Tachina flies which are similar to and larger than the ordinary house fly. These beneficial parasites deposit oval, rather conspicuous white eggs on the caterpillars, usually just a little behind the head. An abundance of these flies or other natural enemies such as the ferocious ground beetles may render it unnecessary to take active measures for the destruction of the caterpillars, because under such conditions there is comparatively little danger of any number attaining maturity. On the other hand, indiscriminate destruction of the parasitized caterpillars may result in the annihilation of numerous beneficial insects.

Luminous larvae (Phengodes plumosa Oliv.). The common lightning bug or more properly lightning beetle, Photuris pennsylvanica DeG. is well known, though its luminous larvae, occasionally observed in decaying wood,

are rarely seen. The past season our attention was called to two pale yellowish, rather slender, curled larvae about an inch and a quarter long and resembling in a general way, the more familiar larvae of the snapping beetles, though easily distinguished therefrom by their luminosity. These larvae, kindly identified by Mr H. G. Barber through the courtesy of Dr Howard, proved to be half grown individuals of the northern form of Phengodes plumosa Oliv. They were taken by Mr Joseph E. Brown in Fairfield co., Connecticut. This species undoubtedly occurs in New York State. Similar luminous larvae were found in some numbers about Newton Centre, Mass. in June 1873 and have subsequently been observed from time to time and for the most part were supposed to belong to the genus Melanactes or Asaphes.

The full grown larva is about an inch and half long and may be at once recognized in the dark at least, by the bright light shining from the spiracles and visible through the membranes connecting the different segments of the body. A larger species, Phengodes laticollis Lec. has a larva 2¾ inches long which, according to Prof. G. F. Atkinson, produces a brilliant, bluish white light visible both through the spiracles and the membranes connecting the body segments. The male of this form is comparatively insignificant, being only about ¾ of an inch in length. An interesting fact in connection with these insects is that this grublike, luminous form remains in this condition when mature, being simply a wingless, larviform female. These peculiar insects occur in the ground and have been observed about the roots of grasses and under hedges. They come from their retreats at night, at which time they are most likely to be seen.

A museum pest (Anthrenus verbasci Linn.). It is well known that this small beetle, easily distinguished from the larger, more brightly colored, red, white and black carpet beetle, Anthrenus scrophulariae Linn. by its dull yellowish and gray, irregular markings, feeds upon a considerable variety of dry animal and vegetable substances. Two ears of corn infested by this insect were received April 4, 1902 and placed in a two-quart Mason jar and kept tightly closed. There was no moisture aside from that in the somewhat dried corn. Breeding has continued uninterruptedly to June 1910, a period of over eight years. At the end of this time the bottom of

the jar was nearly covered with fine, white, globose particles, apparently starch grains falling from the eaten kernels of corn, and a thick mass of the brown larval skins and other debris. This record is interesting since it shows how long an insect is capable of subsisting under such adverse conditions.

Shade tree pests

Elm leaf beetle (Galerucella luteola Mull.). This notorious shade tree pest continues to attract notice on account of the serious injuries inflicted upon elm trees, especially the European species. A noteworthy feature has been, judging from the reports and specimens, the unusual abundance of this insect on Long Island. Reports accompanied by specimens showing serious injury were received from Northport, St James, Oakdale and Greenport. The pest was injurious in the Hudson valley and would have caused extensive defoliation in Albany and Troy if it had not been for the systematic spraying of most of the trees. This insect continues to be a pest in Saratoga Springs and at Sandy Hill a number of trees have been partially defoliated as a result of its work. Complaints of injury were also received from Schenectady. Specimens of this beetle were received from Amsterdam, a new though by no means unexpected locality. This pest will probably continue to spread through the Hudson valley and become a rather serious pest in many cities and villages in western New York. It is already ranked as one of the most dangerous shade tree pests in Ithaca on account of the ravages of the past few years.

Experience has repeatedly demonstrated the possibility of keeping the foliage, even of European elms practically intact throughout the season by thorough and timely spraying with an arsenical poison. There is frequently difficulty in getting the work executed in a proper manner. Altogether too often, possibly through a mistaken notion of economy, the beginning of operations is so greatly delayed in the spring that it is impossible to spray the trees satisfactorily within the time during which such work can be done to advantage. The most effectual spraying for elm leaf beetle must be done between the middle of May and the 25th of June. It is practically useless to apply poison after the grubs commence to forsake the trees, unless the foliage has been so thoroughly skeletonized that the majority of the leaves will drop and a new crop ap-

pear. Spraying for the protection of these latter is always justified by results and late applications may also be serviceable in protecting foliage which had escaped injury earlier in the season. Altogether too few realize the very limited time during which work against this species can be prosecuted to advantage and only occasionally do we run across a party who appreciates what can be accomplished by thorough and timely work.

Bronze birch borer (Agrilus anxius Gory). This pernicious enemy of birch trees has continued its ravages here and there throughout the State. It is particularly common in Rochester, Buffalo and vicinity, where numerous trees have been destroyed and others are being killed. It is worse than useless to leave an affected tree standing, since the borers in the bark appear another spring and continue their destructive operations. There is nothing better than to cut and burn, during the winter or early spring, all birch trees or portions of trees showing the characteristic dying of the top, produced by the operations of this flat-headed borer.

Sugar maple borer (Plagionotus speciosus Say). Retiring though this insect may be in its habits, it is nevertheless one of the important enemies of our sugar maples. Investigations last summer resulted in finding several magnificent trees at Fulton, N. Y. which had been seriously injured, if not practically destroyed by this pest. At the time of our visit July 13, the black, brilliantly golden marked, stout beetles were extraordinarily numerous upon several trees, as is evidenced by our capturing 10 or 12 within 30 minutes. Never before have we found the insects so abundant in a locality. The beetles deposit their eggs in midsummer in slitlike gashes here and there in the bark, particularly at the base of the larger limbs, the sap flowing from the wounds usually producing an oval, discolored area, which is frequently made more conspicuous by a few particles of borings hanging from a slender thread. The young grubs may be found near the point of entrance during the fall and early spring. The second year the grub has increased materially in size and when full-grown may make a transverse or oblique gallery just under the bark and continue sometimes half way around a tree 18 inches in diameter. This practically girdles the maple and is almost invariably followed by the bark slowly dying on the affected

side, until eventually half of the tree may succumb to the injury. This pest, besides breeding in the trunk as described, also injures the branches, not infrequently causing the death of one or two limbs or possibly of all those on one side of the tree.

Affected trees should first have all the dead wood removed so far as possible, taking care to protect the cut surfaces with applications of tar or any good roofing paint. Next, carefully examine the trees for signs of borers, digging out the pests if possible, since the pernicious grubs if left to themselves, are likely to cause much more injury than would result from the judicious use of the knife. Wounds of this character should be carefully protected with tar or paint. Each fall the trees should be closely examined for irregular, discolored patches about the size of a nickel, caused by the sap oozing from the slitlike oviposition scars. It is comparatively easy to dig out the young grubs. Their early destruction is much more preferable to extended excavations in search of the nearly full-grown borer.

European elm case bearer (Coleophora limosipennella Dup.). The peculiar, somewhat flattened cases of this species were first brought to the writer's attention in 1901. It is a European form which evidently became established in this country at about that period and is now generally distributed in the vicinity of New York city. Complaints of injury, accompanied by infested leaves, were received from Oakdale, N. Y. The writer observed it at Oyster Bay in 1906, at which time its operations approached in seriousness those of the much better known elm leaf beetle. The general injury by these two forms is somewhat similar, though easily distinguished. The areas mined by the case bearers are distinctly rectangular and bounded on either side, as a rule, by a parallel vein and extending rather evenly for some distance from the central feeding hole, the latter easily seen when looking upward toward a bright sky. The eroded, semitransparent, skeletonized areas produced by elm leaf beetle larvae are at once distinguished by their greater irregularity, the lack of the central feeding orifice and the fact that there is no mining of the foliage. This more recently introduced pest should be watched closely and can be controlled by early and thorough spraying with an arsenical poison, making the application at the time the leaves begin to appear.

False cottony maple scale (Phenacoccus acericola King). This insect has been abundant and injurious in the vicinity of New York city in recent years. The city of Mount Vernon appears to have been one of the chief sufferers, judging from specimens and communications received from that locality. This pest is easily distinguished from the older and better known cottony maple scale[1] by the fact that it occurs in conspicuous felted masses upon the trunks of infested trees and also has large, cottony aggregations on the foliage, two situations where the cottony maple scale is never found with its conspicuous white covering. The last named insect, though its inconspicuous naked young occur upon the foliage, is rarely observed except on the underside of the limbs after the females have developed their characteristic, cottony masses protruding from under a conspicuous brown scale. This species can be controlled by thorough applications, in winter or early spring, with a contact insecticide, using one pound of whale oil soap to a gallon of water. The kerosene emulsion, the standard formula diluted with four parts of water, has been found very effective in controlling the cottony maple scale and would doubtless prove equally efficient in the case of its associate. Several oil preparations now on the market under various trade names have also been used successfully.

Forest insects

Snow-white linden moth (Ennomos subsignarius Hubn.). This destructive span worm first came to notice in recent years during the summer of 1907 because of extensive defoliations in the Catskills. The ravages of that season were more extended the following summer and then included areas in the Adirondacks as well as in the Catskills. The extended outbreak of 1908 was also accompanied by noteworthy flights of the snow-white millers in many cities and villages of the Hudson valley. The past season has again witnessed extensive injury in the Catskills, this pest causing a large amount of damage to forests in the vicinity of Cooks Falls, Delaware co. and being particularly injurious in the township of Denning, Ulster co. Mr Alexander Tison, writing of conditions under date of June 24, states that in 1908 the measuring worm de-

[1] Pulvinaria vitis Linn.

nuded great tracts of timber on the mountain side and reports that while the worms are still very young there is every indication that they will be more numerous than they were last year. The prediction appears to have been abundantly verified by subsequent experience. Mr Walter Hannah of Poughkeepsie states that on July 4 he ascended Slide mountain and on the next day crossed Mount Cornell and the Wittenberg. All the way up from Winnesook lake the trees and undergrowth were literally covered with caterpillars which were eating leaves and strewing the ground with irregular shaped pieces. The pests were particularly bad on the maples and birches. Mrs Olive Wade of Brooklyn also records extensive injuries in the township of Denning. Mr Walter W. Lewis of Dahlia, Sullivan co. reported under date of July 26 that these caterpillars had defoliated hundreds of trees on his farm and in the adjoining neighborhood.

The remarkable flights of moths recorded in 1908 were repeated in 1909. Swarms of the moths or millers about the street lights in New York city this season were recorded by the *Daily Press* of July 26 and a similar flight though not so extensive was observed in Albany the night of July 29. The remarkable urban visitations of 1908 were not followed, as was anticipated, by unusual injury to shade trees and the same would undoubtedly be true of the outbreak the past season. The English sparrow, as recorded previously, displayed most commendable activity in following up and destroying the moths and was probably an important factor in preventing injuries to shade trees.

We would reiterate that the recent extended outbreaks by this leaf feeder and other enemies destructive to forest trees must, in our judgment, be attributed in large measure to the relative paucity of bird life. Some years ago Dr William T. Hornaday of the New York Zoological Society calculated that there had been a decrease of about 48% in the number of our native birds. This estimate, taken in connection with the enormous number of insects devoured by birds, is exceedingly significant. For example, a pair of tanagers has been observed to eat 35 newly hatched caterpillars in a minute and to continue this for 18 minutes, making a total in this short time of 630 caterpillars destroyed. Two Maryland yellowthroats, it is estimated, devoured 7000 plant lice within an hour. A nearly fledged young crow, it is stated, requires at least 10

ounces of food daily, while an adult needs 8 ounces. Birds, on account of their great mobility, are admirably fitted to concentrate their attacks upon outbreaks of leaf-feeding caterpillars. Repeated observations by competent naturalists have shown that this frequently occurs in nature. The reckless and criminal slaughter of these beneficial forms in recent years is beginning to have its effect upon animal and vegetable life and we are just commencing to harvest the results. The indiscriminate destruction of bird life should be checked at once by prohibiting promiscuous shooting, by suppressing egg destruction or egg collection by boys, by doing away with cats so far as possible and by keeping hawks, crows and jays within bound. Some attention should also be given to rendering local conditions more attractive to birds. The adoption of such measures, we believe, would have a most important influence in checking the above mentioned and similar outbreaks. This would not mean large expenditures and, if generally supported, would do much toward repopulating the country with its normal quota of birds and thus in large measure restoring the balance of nature. Owing to the extensive areas infested and the comparatively low price of wood and its products, we can hardly hope for the adoption of other methods for some years to come. More extended discussions of this insect have been given by the writer in the 23d[1] and 24th[2] reports.

Spruce bud moth (Tortrix fumiferana Clem.). The past season was noteworthy because of an unusual flight in late July, of the small, brown moths belonging to this species. These insects were sufficiently abundant to attract local notice in Albany, Utica, Rome, Auburn, Syracuse, Geneva, Batavia, Binghamton, Ithaca, Olean, Boonville and doubtless many other localities. This insect is well known as a serious enemy of spruce. It was considered by Dr Packard as one of the most destructive enemies of this valuable tree in certain portions of Maine. The unusual abundance of this insect over such a large territory is undoubtedly due to favorable climatic or other conditions and may possibly be followed by a serious injury another season. It may be that this general record is to be explained by the earlier flight of the snow-white linden moth drawing attention to other insects and resulting in many observations of phenomena which otherwise might have passed unrecorded.

[1] N. Y. State Mus. Bul. 124. 1908. p. 23-28.
[2] N. Y. State Mus. Bul. 134. 1909. p. 51-54.

Hickory bark borer (Eccoptogaster quadrispinosus Say). An examination of the hickories in Prospect park, Brooklyn, in company with arboriculturist J. J. Levison, showed that a large number of the magnificent hickories in that extensive park were so seriously affected by this pernicious borer that it will be necessary to cut out many trees in order to save the remainder. This bark borer must be ranked as one of the most dangerous enemies of the hickory, since it has destroyed, in recent years, thousands of trees in central New York and is still continuing its nefarious work. The great trouble with outbreaks of this character is that many of the trees are practically killed before trouble is suspected. For example, an examination in September of many supposedly fine trees in Prospect park revealed the fact that numerous borers had entered the trees and that millions of grubs had nearly completed the girdling by running tortuous channels in the inner bark and sapwood. Aside from a few brown leaves here and there at the tips of branches killed by beetles feeding in the petioles and a few extremely inconspicuous fine borings scattered in the crevices of the bark, there was practically nothing externally to indicate the condition of affairs. This dark brown or black, rather stout, cylindrical beetle about 1/5 of an inch long invariably starts its gallery under a protecting scale of bark and owing to the regularity of the cracks in hickory, these hidden points of entry are usually in series one above another. To make matters even worse the obscure initial attack is very likely to occur about the middle or the upper portion of the trunk where observation is extremely difficult. The beetles begin their galleries the latter part of June or throughout July. At the time of our investigation many of the grubs were more than half grown, while a few had nearly attained full size.

There is only one thing to do in the case of a serious infestation such as that detailed above. All badly infested trees or portions of trees should be cut and the bark at least burned before the following April in order to prevent grubs now in the bark from maturing and changing to beetles which another season might continue the destructive work in previously uninfested trees. Thorough spraying of specially valuable trees the latter part of May or early in June with arsenate of lead used at the rate of 6 to 8 pounds to 50 gallons of water should be of considerable service in killing the beetles when they gnaw their way into the twigs and leaf stalks. It is possible that uninfested trees in a section where this pest is

known to be abundant could be protected to a large extent by liberal applications, the last of May, to the bark of the trunk and larger branches, of tree tanglefoot. The discovery in July or early August, of an attack on a previously uninfested tree is not necessarily hopeless, since it should be possible though somewhat expensive, by careful examination to locate most of the points of entrance and kill the beetles or recently deposited eggs (dependent upon the promptness with which operations are begun) by injecting carbon bisulfid or kerosene. This is simply an emergency treatment which might be tried to advantage in case of very highly prized trees.

LIST OF PUBLICATIONS OF THE ENTOMOLOGIST

The following is a list of the principal publications of the entomologist during the year 1909. 70 are given with title,[1] time of publication and a summary of the contents of each. Volume and page numbers are separated by a colon, the first superior figure gives the column and the second the exact place in the column in ninths: e. g. 73:1005[26] means volume 73, page 1005, column 2 in the sixth ninth, i. e. about two thirds of the way down.

Varieties of the Tussock Moth. Country Gentleman, Oct. 22, 1908, 73:1005[26]

Brief descriptive notices of the white marked tussock moth. Hemerocampa leucostigma Sm. & Abb., the hickory tussock moth, Halisidota caryae Harr., the well marked tussock moth. Hemerocampa definita Pack. and the old tussock moth, Notolophus antiqua Linn.

Prolificacy of Plant Lice. Commercial West (Minneapolis, Minn.), Jan. 30, 1909, 15:59

Original estimates of the possible prolificacy of the hop plant louse, Phorodon humuli Schrank.

Greenhouse Scale. Country Gentleman, Feb. 4. 1909, 64:104[35]

Remedial measures are given for Lecanium hesperidum Linn.

[1] Titles are given as published and in some instances they have been changed or supplied by the editors of the various papers.

Recent Importations of Brown Tail Moth in French Apple Seedlings. National Nurseryman, Feb. 1909, 17:46-47

General account of Euproctis chrysorrhoea Linn. with special reference to measures for preventing its obtaining a foothold in New York State.

Gall Midges of the Goldenrod. Ottawa Naturalist, Feb. 1909, 22: 244-49

Brief observations on the Cecidomyiid fauna of Solidago with a descriptive list of the galls and their inhabitants, some 35 species being noticed.

The Economic Status of the House-Fly. Economic Entomology Journal, Feb. 1909, 2:39-44

The evidence warrants our considering the house fly, Musca domestica Linn., as an important agent in the dissemination of typhoid fever, certain other grave intestinal disorders, tuberculosis and other serious diseases, especially in warmer climates.

Brown Tail Moth, Euproctis chrysorrhoea Linn. Economic Entomology Journal, Feb. 15, 1909, 2:80

Records the introduction into New York and other states of many winter nests of this insect with recent importations of French seedlings. The resistance of the caterpillars to fumigation with hydrocyanic acid gas is noted.

Oyster Scale. Country Gentleman, Feb. 18, 1909, 74:153[85]

Brief economic account of Lepidosaphes ulmi Linn.

Destroying the Clover Mite. Garden Magazine, March 1909, 9:124

Brief discussion of habits and measures for controlling Bryobia pratensis Garm.

Arsenate of Lead. Country Gentleman, March 11, 1909, 74:235[26]

Recommendations as to the amount of poison which should be used.

Monarch and Mimic. N. Y. State Educ. Dep't, Arbor Day Annual, 1909, p. 20-22

A popular account of the Monarch, Anosia plexippus Linn. and the Viceroy, Basilarchia archippus Cram.

Greenhouse Scale. Country Gentleman, April 1, 1909, 74:320[12]

A general descriptive account of Orthezia insignis Sig., with a discussion of control measures.

The Interpretation of Nature. Entomological Society of Ontario, 39th Rep't, 1909, p. 23–30

A popular lecture giving particular attention to various bark and wood borers, the elm leaf beetle, Galerucella luteola Mull., the snow-white linden moth, Ennomos subsignarius Hubn., the sugar maple borer, Plagionotus speciosus Say, the gipsy moth, Porthetria dispar Linn., the brown tail moth, Euproctis chrysorrhoea Linn., the codling moth, Carpocapsa pomonella Linn., the cigar case bearer, Coleophora fletcherella Fern., the blister mite, Eriophyes pyri Nal., several scale insects and the house fly, Musca domestica Linn.

The Economic Importance and Food Habits of American Gall Midges. Entomological Society of Ontario, 39th Rep't, 1909, p. 43–46

A summary account of the destructiveness and food habits of many species.

Pests of Chestnut Trees. Country Gentleman, April 8, 1909, 74: 344[28]

Brief economic accounts of the two lined chestnut borer, Agrilus bilineatus Weber, and of the chestnut timber worm, Lymexylon sericeum Harr.

Spraying. Country Gentleman, April 8, 1909, 74:346[7]

Brief discussion of the action of the lime-sulfur wash and of methods of spraying for codling moth.

Controlling Codling Moth. Country Gentleman, April 8, 1909, 74:348[12]

A summary statement of results obtained in Washington by modifying the method of spraying for Carpocapsa pomonella Linn.

What Ails Your Plants? Garden Magazine, May 1909, 9:221–25

A comprehensive spray calendar with formulas for the principal insecticides and fungicides.

Anthrenus verbasci Linn. Economic Entomology Journal, April 1909, 2:193

Record of continuous breeding in a closed jar containing dry corn for a period of seven years.

Spraying for the Codling Moth. N. Y. State Fruit Growers Ass'n Proc. 8th Meeting, 1909, p. 113–21

Summary of Professor Melander's discussion of western results in controlling Carpocapsa pomonella Linn.

For Codling Moth. Country Gentleman, April 22, 1909, 74:403[12]

Spray within a week or 10 days after the blossoms fall for Carpocapsa pomonella Linn.

Spray Pumps. Country Gentleman, April 22, 1909, 74:403[26]

The relative value of pressure, vermorel and bordeaux sprays is briefly discussed.

Spray Poisoning. Country Gentleman, April 22, 1909, 74:403[42]

Judicious spraying involves no danger to stock fed or feeding on the grass under the trees, though it is advised to wait 48 hours after the application.

Shade Tree Pests. Troy Press, May 5, 1909

General directions for the control of the elm leaf beetle, Galerucella luteola Mull., and the white marked tussock moth, Hemerocampa leucostigma Sm. & Abb.

Control of Household Insects. N. Y. State Mus. Bul. 129, p. 1–48, fig. 34 (Issued May 7, 1909)

Contents

Grape Blossom Midge. Grape Belt, May 18, 1909, p. 10

A detailed popular account of Contarinia johnsoni Sling., recording the rearing of the adult and making suggestions for the control of the pest.

Spruce Gall Aphis. Country Gentleman, May 20, 1909, 74:500[46]

Brief general account with a description of a new form of injury by Chermes abietis Linn. The latter proves to be Physokermes abietis work.

Cucumber Beetle. Country Gentleman, May 27, 1909, 74:525[12]

A brief discussion of methods for controlling the striped cucumber beetle, Diabrotica vittata Fabr.

Cabbage Worm. Country Gentleman, June 3, 1909, 74:548[43]

Brief discussion of remedies and preventatives for Pieris rapae Linn.

Insecticides and Fungicides. N. Y. State Mus. Educ. Dep't, Handbook 18, April 1909 (Issued June 5), p. 1–22

Gives directions for the preparation and use of the principal insecticides and fungicides.

Caterpillars. Country Gentleman, June 10, 1909, 74:572[16]

A discussion of the value of bands in protecting trees against tent caterpillars, Malacosoma americana Fabr.

Maple Gall. Country Gentleman, June 10, 1909, 74:572[25]

A brief economic account of Eriophyes quadripes Shim.

Codling Moth. Country Gentleman, June 10, 1909, 74:572[37]

A discussion of the essentials to successful spraying for Carpocapsa pomonella Linn.

Further Observations on Contarinia. Economic Entomology Journal, 2:257

The rearing of Contarinia johnsoni Sling. is recorded with observations upon its economic importance.

Bud Worm. Country Gentleman, June 17, 1909, 74:594[27]

Brief descriptive account giving control measures for this species, Tmetocera ocellana Schiff. and the associated case bearers.

An Army Worm Outbreak. Country Gentleman, June 24, 1909, 74:614[25]

Records an outbreak by Heliophila unipuncta Haw. at Oakdale, L. I. and gives remedial measures.

Plum Aphis–Rose Leaf Hopper. Country Gentleman, June 24, 1909, 74:616[11]

General economic account of aphids on plum and other fruit trees with a brief notice of the rose leaf hopper, Typhlocyba rosae Linn.

Plant Lice. Country Gentleman, July 1, 1909, 74:635[12]

Brief observations are given on plant lice with directions for their control.

Save Your Apple Crops from the Canker Worm. Poughkeepsie Evening Star, July 2, 1909, p. 8

A general discussion of Paleacrita vernata Peck with special reference to control measures.

Natural Enemies of Plant Lice. Grape Belt (Dunkirk, N. Y.) July 2, 1909, p. 8

A brief discussion of plant lice and their enemies on elms with observations on methods of control.

Sugar Maple Borer. Country Gentleman, July 8, 1909, 74:654[36]

A brief notice of Plagionotus speciosus Say with suggestions for its control.

Falling Leaves. Country Gentleman, July 8, 1909, 74:655[16]

A short notice of Chaitophorus aceris Linn. with observations on the dropping of leaves.

Controlling Hop Louse. Country Gentleman, July 8, 1909, 74:655[32]

The life history of Phorodon humuli Schrk. is briefly outlined and directions given for its control.

The Birch and Witch-Hazel Louse. Country Gentleman, July 8, 1909, 74:656[11]

The life history of Hamamelestes spinosus Shim. is discussed together with control measures. Directions are also given for controlling elm leaf beetle, Galerucella luteola Mull.

New Species of West Indian Cecidomyiidae. Entomological News, 1909, 20:299–302

The following new species were described: Asynapta mangiferae. Asphondylia attenuatata and Lobodiplosis spinosa,

Snow-White Linden Moth. Argus (Albany), Brooklyn Eagle,

Utica Observer, July 14, 1909; Plattsburg Star, July 13; Catskill Recorder, July 23

A general notice recording injuries in the Catskills by Ennomos subsignarius Hubn. and discussing causes. The desirability of protecting birds is emphasized.

Oak Leaf Miner. Country Gentleman, August 5, 1909, 74:734[34]

A brief descriptive and biologic account of Lithocolletes hamaryella Clem.

Squash Vines. Country Gentleman, August 12, 1909, 74:754[37]

A brief discussion of the squash vine borer, Melittia satyriniformis Hubn. and the striped cucumber beetle, Diabrotica vittata Fabr.

Tortoise Beetle. Country Gentleman, August 12, 1909, 74:755[24]

A short descriptive account of the golden tortoise beetle, Coptocycla bicolor Fabr.

Gipsy and Brown Tail Moth Work. Country Gentleman, August 12, 1909, 74:756[23]

A general review summarizing the accomplishments and pointing out the mportant phases of this work against Porthetria dispar Linn. and Euproctis chrysorrhoea Linn.

Additional Rearings in Cecidomyiidae. Economic Entomology Journal, August 1909, 2:286–93

Records the rearing of 40 species, 37 being briefly described as new. A new genus, Caryomyia, with Cecidomyia tubicola O. S. as type, was erected.

Scientific Notes. Economic Entomology Journal, August 1909, 2:306–7

The following species are noticed: The snow-white linden moth, Ennomos subsignarius Hubn., a number of the more injurious Aphididae and the brown tail moth, Euproctis chrysorrhoea Linn.

Cabbage Lice. Country Gentleman, August 19, 1909, 74:775[17]

A brief discussion of Aphis brassicae Linn. and methods for its control.

Unicorn Prominent. Country Gentleman, August 19, 1909, 74:775[20]

A brief descriptive account of Schizura unicornis Sm. & Abb.

Squash Bugs. Country Gentleman, August 19, 1909, 74:775[23]

A general economic account of Anasa tristis DeG.

Strawberry Grubs. Country Gentleman, August 19, 1909, 74:775[48]

Remedial measures are given for these pests.

Where this Year's Insects Came From. Garden Magazine, September 1909, 10:68-69

A general discussion of the causes of insect outbreaks with special reference to the excessive numbers of plant lice. A few of the more injurious or more interesting aphids are briefly noticed.

Lilac Borer. Country Gentleman, August 26, 1909, 74:803[17]

A brief economic discussion of Podosesia syringae Harris.

Probably Elm Leaf Beetle. Country Gentleman, August 26, 1909, 74:822[18]

A summarized account of Galerucella luteola Mull. with special reference to control measures.

Worst than Most Diseases. Country Gentleman, September 9, 1909, 74:859[21]

The characteristics of the San José scale, Aspidiotus perniciosus Comst. are given and spraying with a lime-sulfur wash is advised.

Cutworms in Corn. Country Gentleman, September 9, 1909, 74:859[25]

A general descriptive account of the corn ear worm or boll worm, Heliothis armiger Hubn.

The Sugar Maple Borer. Country Gentleman, September 9, 1909, 74:859[34]

A general account of Plagionotus speciosus Say with a discussion of remedies.

Apples Injured by Insects. Country Gentleman, September 9, 1909, 74:859[43]

A discussion of the causes producing deformed apples, aphids or plant lice, the tarnished plant bug, Lygus pratensis Linn. and the curculio injury being described.

A Caterpillar. Country Gentleman, September 16, 1909, 74:880[47]

A brief descriptive account of Basilona imperialis Drury.

Oak Caterpillar. Country Gentleman, September 23, 1909, 74:904[36]

A general descriptive account of *Anisota senatoria* Sm. & Abb.

Luminous Larvae. Country Gentleman, September 23, 1909, 74:907[35]

The half grown larva of *Phengodes plumosa* Oliv. is identified and several allied luminous forms, *Phengodes laticollis* Lec., *Photuris pennsylvanica* DeG. and *Pyrophorus noctilucus* Linn. are briefly noticed.

The Grain Weevil. Country Gentleman, September 23, 1909, 74:907[44]

The Angoumois moth, *Sitotroga cerealella* Oliv. is presumably the pest. A brief economic account is given of this species.

24th Report of the State Entomologist on Injurious and Other Insects of the State of New York. 1908. N. Y. State Mus. Bul. 134, 206p. 17 pl. 1909 (Issued Sept. 27)

Contents

A Diseased Elm Tree. Country Gentleman, October 7, 1909. 74:951[42]

Directions are given for controlling the elm leaf beetle, *Galerucella luteola* Mull., the possible cause of the trouble.

Insects and Legislation. Economic Entomology Journal, 2:342-45

A summarized discussion of legislation relating to insects.

ADDITIONS TO COLLECTIONS, OCT. 16, 1908–OCT. 15, 1909

The following is a list of the more important additions to the collection.

DONATION

Hymenoptera

Sphecodes fragariae Ckll., S. sophiae Ckll. var. Halictus scrophularia Ckll., Augochlora neglectula Ckll., Andrena prunorum gilletti Ckll., Panarginus cressoniellus Ckll., Feb. 16, Prof. **T. D. A. Cockerell,** Boulder, Col.

Steniolia obliqua Say, Trypoxylon frigidum Sm., Thyreopus latipes Sm., Andrena geranii Rob., A. porterae Ckll., A. prunorum Ckll., Nomada collinsiana Ckll., Osmia fulgida Cress., Dianthidium parvum Cress., Megachile pugnata Say, Ceratina neomexicana Ckll., Melissodes obliqua Say, M. agilis Cress., Anthophora simillima Cress., Nov. 12, **S. A. Rohwer,** Boulder, Col.

Xylocopa virginica Dru., large carpenter bee, adult, June 28, Miss **M. A. Batly,** Schaghticoke

Agapostemum viridula Fabr., solitary digger bee, adult, July 9, **Leslie Crane,** Rutland, Vt. Through Doubleday, Page & Co., New York

Thalessa atrata Fabr., black long sting, adult, June 24, **O. D. Patterson,** Richburg

Rhodites rosae Linn., rose bedegar, gall on rose, July 10, Miss **L. M. Hasbrouck,** Ogdensburg

Andricus clavula Bass., oak tip gall on white oak, October 23, **H. L. Frost & Co.,** White Plains

Lophyrus lecontei Fitch, pine sawfly, larvae on pine, July 31, Miss **Josephine Goldmark,** St Huberts

Emphytus cinctus Linn., coiled rose slug, larva on rose, January 30, **Percy L. Huested,** Rochester

Amauronematus azaleae Marlt., larvae on azalea, June 8, **J. A. Thomson,** Rochester

Kaliosysphinga ulmi Sund., elm leaf miner, larvae on elm, June 7, **J. H. Livingston,** Tivoli. Same, June 17, **J. A. Thomson,** Rochester

Lygaeonematus erichsonii Hart., larch sawfly, larvae on larch, June 28, Miss **Rhoda Thompson,** Ballston Spa

Tremex columba Linn., pigeon Tremex, adult, September 13, **D. D. Hoover,** Syracuse. Same, adult on maple, September 22, **R. Closson,** Addison

Coleoptera

Hylesinus aculeatus Say, ash bark beetle, adults, eggs and larvae on ash, May 18, **Barton & Spooner Co.,** Cornwall. Through Forest, Fish and Game Commission

Eccoptogaster quadrispinosus Say, hickory bark borer, larvae on hickory, October 28, **J. J. Levison,** Brooklyn; Same, adult and larvae on hickory, September 17, **D. D. Hoover,** Syracuse

Pomphopoea sayi Lec., Say's blister beetle, adults on rose, June 28, **Paul Roach,** Quaker Street

Epicauta ? puncticollis Mann., blister beetle, adults, July 24, **E. B. Peterson,** Chatham. Through T. F. Niles

Disonycha pennsylvanica Ill., adult on apple trees, March 31, **E. B. Norris,** Sodus

Galerucella luteola Mull., elm leaf beetle, larvae on elm, July 12, **George Zabriskie,** Nissequogue, St James, L. I. Same, July 8, **Mrs H. Fletcher Fordham,** Greenport, L. I. Through Forest, Fish and Game Commission. Same, July 14, **J. H. Fish,** Greenport, L. I. Same, larvae and pupae, August 18, Mrs **Albert Delafield,** Greenport, L. I. Same, July 23, **P. B. McKensie,** Northport, L. I. Same, July 26, **John O. Van Clefe,** Oakdale. Same, August 5, **E. M. White,** Sag Harbor, L. I. Same, August 24, **C. L. Simpson,** Amsterdam

Trichius affinis Gory, adult, July 15, Mrs **W. S. Miller,** Boonville

Euphoria inda Linn., flower beetle, adults, September 21, **Frederick Chatfield,** Troy

Macrodactylus subspinosus Fabr., rose beetle, adults, June 19, **G. C. Schaible,** Brooklyn. Same, June 21, **F. Lindquist,** Brooklyn

Chalcophora liberta Germ., smaller flat-headed pine borer, adult, June 3, Miss **Eliza S. Blunt,** New Russia

Phengodes plumosa Oliv., larva, August 9, Ridgefield, Conn. Through Country Gentleman

Asaphes decoloratus Say, larvae killed by a fungus, Cordyceps acicularis Rav. (C. carolinensis B. & R. Ravenel's exsiccati) November 27, **C. W. Nash,** Toronto, Canada

Alaus oculatus Linn., owl beetle or eyed elater, adult, June 23, **Mrs J. D. Patterson,** Pattersonville

Silvanus surinamensis Linn., saw-toothed grain beetle, adult in flour, April 20, **J. A. Hepworth,** Marlborough

Anatis ocellata Linn., larva, pupa and adult on apple, July 1, **Milo F. Winchester,** South Amenia

Nomius pygmaeus Dej., August 21, **S. B. Ferris,** Upper Saranac

Diptera

Rhagoletis pomonella Walsh, many adults on apple, September 10, **C. E. Brisbin,** Schuylerville

R. suavis Loew, adult on apple, September 10, **C. E. Brisbin,** Schuylerville

Bombyliomyia abrupta Wied., adult, August 25, **L. F. Baldwin,** Albany

Numerous Cecidomyiid galls were received from Miss **Cora H. Clarke,** Boston and Magnolia, Mass. and a number of new species reared from the material contributed. [*See* Econ. Ent. Jour. 1909, 2:286–93]

A number of Cecidomyiids were received during the season from Mr **C. P. Alexander,** Johnstown

Rhopalomyia hirtipes O. S., numerous subterranean galls September 2, 1909 from Miss **F. A. Stebbins,** through Dr **George Dimmock,** Springfield, Mass.

Sackenomyia packardi Felt, larvae in willow shoots, April 15, **Winthrop Packard**, Canton, Mass.

Lasioptera tripsaci Felt, adults reared from Tripsacum dactyloides, Texas, **F. M. Webster**, Washington, D. C.

Cecidomyia opuntiae Felt, reared from Opuntia leaves, **George V. Nash**, Bronx Park, New York

A number of other gall midges have been received from various parties and will be duly acknowledged in subsequent descriptions or discussions of the species.

Lepidoptera

Sphecodina abbotii Swain, Abbot's sphinx, larvae on woodbine, July 30, Miss **Emma S. Call**, Northport. Same, larvae, August 12, Mrs **A. Openhym**, St Huberts

Deilephila lineata Fabr., white lined sphinx, moth, September 11, **Bell & Smith Nursery Seed Co.**, Castleton

Sphinx drupiferarum Sm. & Abb., plum sphinx, adult, June 7, **Ezra Shults**, Fort Plain

Sphinx chersis Hubn., ash sphinx, adult, July 26, **H. H. Fitch**, West Winfield

Halisidota caryae Harr. on elm, August 18, Mrs **Albert Delafield**, Greenport

Heliophila unipuncta Haw., army worm, larvae, June 17, **George P. Slade**, (New York city) Oakdale

Heliothis armiger Hubn., corn worm, larvae on corn, October 19, Dr **C. W. Frispell**, Shelter Island Heights

Melalopha inclusa Hubn., poplar tent maker, larvae on poplar, August 2, **Jarvis W. Baxter**, Adams Corners

Notolophus antiqua Linn., dark or rusty tussock moth, larvae, June 29, **E. Dillingham**, Ogdensburg

Tolype velleda Stoll., larch lappet, larva, July 23, **Charles Burbank**, LaGrangeville

Paleacrita vernata Peck, spring canker worm, larvae on apple trees, May 31, **Ernest Emans**, LaGrangeville

Alsophila pometaria Harr., fall canker worm, adults, Nov. 30 & Dec. 2, **Augustus Floyd**, Moriches

Acrobasis feltella Dyar, larvae on hickory, June 12, Mrs **A. M. A. Jackson**, Warner

Archips cerasivorana Fitch, ugly nest cherry worm, nest, July 17, **P. L. Huested**, Blauvelt

Tortrix fumiferana Clem., spruce bud worm, adults July 21, **G. A. Bailey**, Syracuse. Same, July 22, **Richard Lohrmann**, U,tica

Coleophora fletcherella Fern., cigar case bearer, larvae on apple, June 16, **F. A. Fitch**, Randolph

Coleophora limosipennella Dup., European elm case bearer' cases and adults, August 4, **John O. VanClefe**, Oakdale

Antispila nyssaefoliella Clem., larvae and work on pepperidge, September 25, **Roy Latham**, Orient Point

Corrodentia

Psocus salicis? Fitch, nymph in house, November 4, **S. H. Burnham**, Vaughn

Hemiptera

Enchenopa binotata Say, 2-spotted tree hopper, egg masses on bittersweet, August 25, **Paul Cook,** Troy

Belostoma americanum Leidy, electric light bug, adult, October 26, **J. R. Gillett,** Kingston

Leptobyrsa explanata Heid., lace-winged bug, larvae on Rhododendron, June 8, **J. A. Thomson,** Rochester. Same, adult, July 5, **P. L. Huested,** Blauvelt

Aelyrodes citri Riley & Howard, white fly on orange leaf, June 15, Florida. Through J. F. O'Mara, Cornwall

Phyllaphis fagi Linn., woolly beech leaf aphis, adults on beech, May 15, **J. H. Livingston,** Tivoli

Chermes strobilobius Kalt., spruce gall aphid, galls on spruce, May 3, **P. L. Huested,** Blauvelt

C. pinicorticis Fitch, pine bark aphid, adults on pine, March 30, Mrs **George W. Ray,** Norwich. Same, adults and eggs on balsam, September 11, **E. & W. G. Breithaupt,** Phoenicia. Same, adults on pine, September 14, **J. H. Livingston,** Tivoli

C. abietis Linn., spruce gall aphid, galls on spruce, March 8, **William B. May,** Irvington. Same, August 14, **C. R. Pettis,** Lake Clear Junction

Phylloxera caryaecaulis Fitch, hickory gall aphid, adults and young on hickory, June 30, **F. S. Witherbee,** Port Henry

Pemphigus vagabundus Walsh, galls on poplar, July 30, **Henry Ackley,** Cambridge. Same, August 11, **C. H. McCullock,** Schenectady

P. populi-transversus Riley, galls on poplar, July 30. **Henry Ackley,** Cambridge

Colopha ulmicola Fitch, cockscomb elm gall on elm, July 19, **W. C. Donnan,** LeRoy

Schizoneura americana Riley, woolly elm leaf aphid, adults on elm, July 6, **John Allis** jr, Rye. Through H. W. Niles. Same, June 25, Mrs **H. D. Graves,** Ausable Forks

Lachnus dentatus LeBaron, adult on willow, September 23, **Bloodgood Nurseries,** Flushing. Through Theodore Foulk

Callipterus ulmifolii Monell, elm leaf aphid, badly infested leaves of elm, June 29, **H. G. Jones,** Dunkirk

Psyllid, June 17, **J. A. Thomson,** Rochester

Chrysomphalus dictyospermi Morg., Morgan's scale, all stages, abundant and causing serious damage on palm, December 28, **L. Menand,** Albany

Eulecanium tulipiferae Cook, tulip tree scale, adults on tulip, September 14, **J. H. Livingston,** Tivoli

Coccus hesperidum Linn., soft scale, young and adults on begonia, December 12, **H. VanAlstyne,** Chatham Center

Phenacoccus acericola King, false maple scale, young on maple, November 10, **Arthur Dummett,** Mt Vernon

Pulvinaria vitis Linn., cottony maple scale, adults on maple, June 21, **J. A. Thomson,** Rochester

Gossyparia spuria Modeer, elm bark louse, adult on elm, June 21, **Thomas J. Riley,** Catskill. Through Percy L. Huested

Aulacaspis rosae Sandbg., rose scale, eggs, on blackberry, April 22, Miss **Francis Foley,** Cornwall

Aulacaspis pentagona Targ., West Indian peach scale on Prunus pseudo-cerasus from New Rochelle through T. F. Niles, State Department of Agriculture

Chionaspis pinifoliae Fitch, pine leaf scale on spruce, January 5, **Arthur Gibson,** Ottawa. Canada. Same, on Austrian pine, September 11, **Theodore Foulk,** Flushing

Aspidiotus forbesi John., on apple, November 6. **Charles A. Richmond,** East Aurora

A. ostreaeformis Curt. on apple, pear and plum, October 29, **Thomas Cunningham,** Vancouver, B. C.

A. perniciosus Comst., San José scale, adults on apple, April 10, **A. C. Burt,** Owego. Same, June 1, **A. J. Smith,** Rexford Flats

Draeculacephala reticulata Sign., Deltocephalus sonorus Ball, D. flavicosta Stal., D. nigrifrons Forbes, D. obtectus O. & B., D. inimicus Say, Xestocephalus pulicarius VanD., X. brunneus VanD., Eutettix strobi Fitch, E. stricta Ball. Acinopterus acuminatus VanD., Phlepsius spatulatus VanD., Athysanus exitiosus Uhler, Platymetopius near loricatus VanD., Scaphoideus consors Uhler, typical, S. immistus Say, Typhlocyba vulnerata Fitch, T. comes Say, T. sp. (near trifasciata), T. comes var. vitis Harr., T. tricincta Fitch, Oliarus complectus Ball, Pissonotus delicatus VanD., P. basalis VanD., P. ater VanD.?, Liburnia pellucida Fabr.?, L. consimilis VanD., Empoasca mali LeBaron, E. flavescens Fabr., E. sp. new, Balclutha abdominalis VanD.?, Nysius minutus Uhler, Reuteroscopus ornatus Reut., Atomoscelis seriatus Reut.?. From Mrs **P. L. Windsor,** Austin, Tex. Very kindly determined by E. P. VanDuzee of Buffalo

Orthoptera

Oecanthus niveus DeG., snowy tree cricket, eggs on raspberry, April 3, **Lansing Appleby,** Clarksville

Periplaneta americana Linn., American cockroach, adult, April 10, **J. A. Thompson,** Syracuse

Mantis religiosa Linn., European Mantis, egg mass, February 15, **Louis H. Adams,** Canandaigua

Thysanura

Achorutes nivicola? Fitch, very abundant on sand, April 8, **Jackson & Perkins,** Newark

Isoptera

Termes flavipes Linn., white ants, adults, April 19, **M. W. VanDenburg,** Mt Vernon

EXCHANGE

Hymenoptera

Tucker, E. S., Manhattan, Kan. Trypoxylon carinifrons Fox, Polistes minor Beauv.

Coleoptera

Berosus subsignatus Lec., Psyllobora taedata Lec. Conotelus stenoides Murr., Scaptolenus lecontei Salle, Photinus benignus Lec., Lobetus abdominalis Lec.

Diptera

Beskia aelops Walk., Sturmia distincta Wied., Sarcophaga assidua Walk., S. quadrisetosa Coq., Pseudopyrellia comicina Fabr., Pachycerina clavipennis Coq.

Lepidoptera

Chlorochlamys phyllinaria Zell., Loxostege mancalis Led., Lineodes integra Zell., Crambus teterrellus Zink., C. mutabilis Clem., Saluria tetradella Zell., Pterophorus inquinatus Zell., Platynota nigrocervina Wals., Anaphora popeanella Clem.

PURCHASE

House fly, Musca domestica Linn. (x 30), model
Malarial mosquito, Anopheles, dissectible model of head. (x 800)
House mosquito, Culex pipiens Linn., dissectible model of head. (x 800)
The above from **The Kny-Scheerer Co.,** New York city

INSECT COLLECTIONS

Summary statement

The total number of insect specimens in the collections approximates 150,000 distributed about as follows:

Orthoptera	1 770	Lepidoptera	31 624
Odonata	987	Diptera	24 953
Neuroptera	1 001	Coleoptera	40 267
Hemiptera	12 113	Hymenoptera	11 917

The alcoholic material belonging in various groups amounts to some 25,000 specimens.

The Hill collection, included in the above estimate, comprises some 10,000 specimens of Lepidoptera.

The Lintner collection, also included in the above enumeration, comprises some 19,228 specimens, distributed as follows: Orthoptera 91; Odonata 241; Neuroptera 230; Hemiptera 1377; Lepidoptera 10,182; Diptera 978; Coleoptera 5002; Hymenoptera 1126.

There are on exhibition some 5746 specimens, distributed as follows: Orthoptera 146; Odonata 31; Neuroptera 43; Hemip-

tera 1036; Lepidoptera 1500; Diptera 401; Coleoptera 2000; Hymenoptera 588. There are also on exhibition 51 photographs, 57 illustrations, 17 models, 14 biological groups and 38 special mounts.

The collections contain some 700 types and about 1500 figured specimens.

INSECT TYPES IN NEW YORK STATE MUSEUM

The following list of insect types is placed on record for the convenience of students and also as a tangible evidence of the growing value of the New York State collections. The court of ultimate appeal in the identification of a species is found in the type — frequently unique. A knowledge of the whereabouts of all such specimens is therefore very important to the systematic worker. The long list of the writer's Cecidomyiid types is not included, since it is planned to indicate the location of these in the monograph on this group, now almost complete.

HYMENOPTERA

Eniscopilus arcuatus *Felt*
E. appendiculatus *Felt*
Ophion abnormum *Felt*
O. ferruginipennis *Felt*
Genophion gilletti *Felt*
G. coloradensis *Felt*

DIPTERA

Culicelsa auroides *Felt*
Culicada abfitchii *Felt*
C. abserratus *Felt & Young*
C. cinereoborealis *Felt & Young*
C. fitchii *Felt & Young*
C. lazarensis *Felt & Young*
C. onondagensis *Felt*
C. subcantans *Felt*
Culiseta absobrinus *Felt*
C. magnipennis *Felt*
Culex brittoni *Felt*
Corethra karnerensis *Felt*
C. lintneri *Felt*
C. fuliginosus *Felt*
Sayomyia rotundifolia *Felt*
S. hudsoni *Felt*
Myzomyia mangyana *Banks* (cotype)
Worcesteria grata *Banks* (cotype)

MYCETOPHILIDAE

Sciara agraria *Felt*
S. caldaria *Lint.*
S. coprophila *Lint.*
S. multiseta *Felt*
S. pauciseta *Felt*
S. prolifica *Felt*

CECIDOMYIIDAE[1]

Dasyneura leguminicola *Lint.*
Aphidoletes cucumeris *Lint.*
Contarinia setigera *Lint.*

[1] There are in addition numerous recently described species which will be fully noticed in a forthcoming publication.

STRATIOMYIDAE

Zabrachia polita *Coq.* (cotype)

EMPIDIDAE

Roederioides juncta *Coq.* (cotype)

ASILIDAE

Dasyllis cinerea *Back.* (cotype)
Cyrtopogon marginalis *Loew* (homotype)
C. lyratus *O. S.* (homotype)

DOLICHOPODIDAE

Dolichopus marginatus *Ald.*

PHORIDAE

Aphiochaeta agarici *Lint.*
A. albidihalteris *Felt*

SYRPHIDAE

Syrphus montivagus *Snow*

TACHINIDAE

Pachyophthalmus floridensis *Town.*
Epigrimyia lucens *Town.*
Spallanzania hebes *Fall.*
Hilarella decens *Town.*
Pegomyia betarum *Lint.*
P. vicina *Lint.*

LEPIDOPTERA

Kricogonia lanice *Lint.*
Chlorippe cocles *Lint.*
Rusticus lotis *Lint.*
Euphyes osceola *Lint.* ?
Thanaos { ausonius *Lint.*
icelus *Lint.* ?
lucilius *Lint.* ?
naevius *Lint.*
pacuvius *Lint.* ?
petronius *Lint.* }
Sphinx insolita *Lint.*
Lapara pineum *Lint.*
Hadena hillii *Grt.*
Melanoporphyria immortua *Grt.*
Tarache terminimaculata *Grt.*
Catocala pretiosa *Lint.*
Xanclognatha inconspicualis *Grt.*
Phaeocyma umbrina *Grt.*
Cerura candida *Lint.*
C. occidentalis *Lint.* ?
Harpyia aquilonaris *Lint.*
Tephroclystis palpata *Pack.*
Venusia perlineata *Pack.*
Euchoeca exhumata *Pears.* (cotype)
Eustroma mucronata *Peck* (disjunctaria *Pack.*)
Racheospila saltusaria *Hulst*
Semiophora badicollis *Grt.*
Agrotis badinodis *Grt.*
Anytus planus *Grt.*
Xylina unimoda *Lint.*
X. lepida *Lint.*
Calocampa nupera *Lint.*
Cucullia matricariae *Streck.*
C. laetifica *Lint.* ?
C. speyeri *Lint.* ?
C. serraticornis *Lint.* ?
Gortyna impecuniosa *Grt.*
Epiglaea venustula *Grt.*
Ipimorpha pleonectusa *Grt.*
Macaria mendicata *Hulst*
Enypia venata *Grt.*
Alcis metanemaria *Hulst*
Lychnosea helvíolaria *Hulst*
Therina somniaria *Hulst*
Gonodontis lentaria *Hulst*
Azelina atrocolorata *Hulst*
Callizzia amorata *Pack.*
Cossus centerensis *Lint.*
C. undosus *Lint.*
Prionoxystus reticulatus *Lint.*
P. querciperda *Fitch*
Hepialus furcatus *Grt.*

HEMIPTERA

Micrutalis (Tragopa) dorsalis *Fh.*
Glossonotus (Thelia) crataegi *Fh.*
Heliria scalaris *Fair.* (Telamona fagi *Fh.*)
Telamona unicolor *Fh.*
T. unicolor *Fh.* fasciata *Fh.*
T. concava *Fh.*
T. coryli *Fh.*
T. coryli *Fh.* tristis *Fh.*
T. querci *Fh.*
T. reclivata *Fh.*
Cyrtolobus (Cyrtosia) fenestratus *Fh.*
C. (Smilia) castaneae *Fh.*
C. (Smilia) querci *Fh.*
C. (Smilia) subsp. guttata *Fh.*
Archasia galeata *Linn.* (Smilia auriculata *Fh.*)
Microcentrus (Uroxiphus) caryae *Fh.*
Cixius pini *Fh.*
Myndus (Cixius) impunctatus *Fh.*
Stenocranus (Delphax) dorsalis *Fh.*
Liburnia (Delphax) arvensis *Fh.*
Lamenia (Poeciloptera) vulgaris *Fh.*
Aphrophora (Lepyronia) saratogensis *Fh.*
Clastoptera obtusa *Say* (testacea *Fh.*)
Clastoptera obtusa *Say* (pini *Fh.*)
C. obtusa *Say* (pini *Fh.*) subsp. flavicollis *Fh.*
C. obtusa *Say* (pini *Fh.*) subsp. cincticollis *Fh.*
C. proteus *Fh.* subsp. maculicollis *Fh.*
C. proteus *Fh.* subsp. nigricollis *Fh.*
Bythoscopus (Athysanus) variabilis *Fh.*
B. (Athysanus) variabilis *Fh.* abietis *Fh.*
B. (Athysanus) fenestratus *Fh.*
B. (Athysanus) minor *Fh.*
B. (Athysanus) fagi *Fh.*
B. (Athysanus) nigrinasi *Fh.*
Pediopsis trimaculata *Fh.*
P. viridis *Fh.*
Idiocerus lachrymalis *Fh.*
I. alternatus *Fh.*
Tettigonia tripunctata *Fh.*
Draeculacephala (Aulacizes) novaeboracensis *Fh.*
Helochara communis *Fh.*
Eucanthus acuminatus *Fabr.* (Evacanthus orbitalis *Fh.*)
Gypona geminata *Osb.*
Penthimia americana *Fh.*
Paramesus (Acocephalus) vitellinus *Fh.*
Platymetopius obscurus *Osb.* (cotype)
P. augustatus *Osb.*
P. fulvus *Osb.*
Deltocephalus (Amblycephalus) sayi *Fh.*
D. (Amblycephalus) melsheimeri *Fh.*
Scaphoideus opalinus *Osb.*
Athysanus (Amblycephalus) curtisii *Fh.*
Eutettix (Bythoscopus) strobi *Fh.*
Phlepsius (Jassus) fulvidorsum *Fh.*
Chlorotettix (Bythoscopus) tergata *Fh.*
C. (Bythoscopus) unicolor *Fh.*
Typhlocyba (Erythroneura) vulnerata *Fh.*
T. (Erythroneura) comes *Say var.* vitis *Fh.*
Aphis gladioli *Felt*
Rhopalosiphum (Aphis) berberidis *Fh.*
Nectarophora (Aphis) rudbeckiae *Fh.*
Schizoneura lanigera (Eriosoma pyri *Fh.*)
Pemphigus (Eriosoma) imbricator *Fh.*

COCCIDAE

Halimococcus lampas *Ckll.*

Coccus diversipes *Ckll.* (part of type)

ALEYRODIDAE

Aleyrodes betheli *Ckll.* (MS) (part of type)

EPHEMERIDAE

Siphlonisca aerodromia *Nedhm.*

Potamanthus inequalis *Nedhm.*

ADDITIONAL LIST OF ADIRONDACK INSECTS

BY D. B. YOUNG

July 20 to August 10, 1909, found the writer enjoying a vacation at Speculator, N. Y., a village with good accommodations, located in the Adirondacks at the foot of Lake Pleasant. The romantic and delightful scenery appeals to one's love of the beautiful, while from an entomologist's point of view the great diversity of plant and insect life of mountain and valley offers exceptional opportunity for collecting many rare and interesting forms. We were particularly impressed by the large representation of Hemiptera in that section and resolved to make a partial collection of the species to be found there and such insects of other orders as might attract our attention. The limited time at our disposal prevented this collection from being as complete as we could wish but the following list will give some idea of the rare forms to be met with in this region.

The Hemiptera were submitted to E. P. VanDuzee, who very kindly made the identifications in that order. Of the 67 species submitted, 25 were new to the State collection. Among new or rare forms in other orders 15 were taken, as well as many others included in the list to preserve the records and make additions to the Adirondack lists already published.

Species marked with a dagger are new to the State collection; those with a star are not in the Adirondack list of Hemiptera in the 20th Report of the State Entomologist.

Hymenoptera

Pemphredon concolor *Say*
Psithyrus ashtoni *Cress.*
Pristiphora identidem *Nort.*
Dolerus aprilis *Nort.*
Strongylogaster pinguis *Nort.*
Harpiphorus articulatus *Nort.*
Emphytus inornatus *Say*
Tenthredo grandis *Nort.*

Coleoptera

†Coeliodes nebulosus *Lec.*
Pseudanthonomus crataegi *Walsh*
†Myodites *sp.*
Anaspis flavipennis *Hald.*
A. rufa *Say*
Phyllobrotica decorata *Say*
Melasoma scripta *Fabr.*
Saperda vestita *Say*
†Leptura biforis *Newm.*
Onthophagus hecate *Panz.*
†Elater hepaticus *Melsh.*
†Cleis picta *Rand.*

Diptera

†Dixa clavulus *Will.*
†Platyura *sp.*
†Sciophila
†Pangonia rasa *Loew*
†Chrysopa eucera *Loew*
C. hilaris *O. S.*

Tabanus reinwardtii *Wied.*
Chrysophila quadrata *Say*
Leptogaster flavipes *Loew*
Dasyllis sacrator *Walk.*
Asilus annulatus *Will.*
Laphria sericea *Say*
†Dolichopus pachycnemus ? *Loew*
D. grata *Loew*
D. detersus *Loew*
†Gymnopternus flavus *Loew*
Chrysotus discolor *Loew*
†Hybos slossonae *Coq.*
†Syneches *sp.*
†Syndyas polita *Loew*
†Leptopeza compta *Coq.*
Trineura aterrima *Fabr.*
†Pipiza pulchella *Will.*
Mesogramma marginata *Say*
Zodion fulvifrons *Say*
Parallelomma varipes *Walk.*
Tetanocera plebeja *Loew*
Sapromyza fraterna *Loew*
S. lupulina *Fabr.*
Tephritis albiceps *Loew*
Sepsis violacea *Meig.*
Loxocera pectoralis *Loew*
Chyliza notata *Loew*
Meromyza americana *Fitch*
Chlorops assimilis *Macq.*
Elachiptera costata *Loew*
Drosophila amoena *Loew*

Lepidoptera

Pieris napi *Linn.*
Petrophora abrasaria *H.S.*
Cleora pampinaria *Guen.*
Pyrausta fumalis *Guen.*
Scoparia basalis *Walk.*
Crambus albellus *Clem.*

Hemiptera

Lygaeidae

*†Nysius ericae *Schill.*
*†Geocoris bullatus *Say*
*Lygaeus kalmi *Stal.*

Capsidae

Trygonotylus ruficornis *Fall.*
*†Resthenia insignis *var. Say*
Neurocolpus nubilus *Say*
Phytocoris eximius *Reut.*
Collaria meilleuri *Prov.*
*†Paracalocoris colon *Say*
*†Lygidae rubecula *Uhl. var* obscura *Reut.*
Lygus pabulinus *Linn.*
*†L. belfragei *Reut.*
*†L. vitticollis *Reut.*
L. invitus *Say*
L. hirticulus *Uhl.*
Hyaliodes vitripennis *Say*
Ilnacora malina *Uhl.*
Pilophorus amoenus *Uhl.*
*†Macrolophus separatus *Uhl.*[1]
*†Mecomma ambulans *Fall.*[2]
Stiphrosoma stygica *Say*
*†Labops burmeisterii *Stal.*[3]
Orthotylus; specimen too immature for identification
Plagiognathus obscurus *Uhl.*
*†P. *sp.*
*Onychumenus decolor *Fall.*

Membracidae

Campylenchia curvata *Fabr.*

Fulgoridae

*Cixius pini *Fitch*
C. stigmatus *Say*
*†Stenocranus felti *VanD.*[4]
Laccocera vittipennis *VanD.*
Liburnia pellucida *Fabr.*
L. lutulenta *VanD.*
*L. arvensis *Fitch*

[1]This species is accredited to the western states in Uhler's list.
[2]Mr VanDuzee states that he has seen but three specimens of this species.
[3]This is the first time this insect has been taken in America so far as we know. It has been recorded from Kamtschatka.
[4]This species is new to New York State.

Cercopidae

*†Aphrophora signoreti *Fitch*
Philaenus lineatus *Linn.*
*†P. spumarius *Germ*
Clastoptera obtusa *Say*

Tettigonidae

Diedrocephala teliformis *Walk.*
Eucanthus acuminatus *Fabr.*
Draeculacephala noveboracensis *Fitch*

Bythoscopidae

Idiocerus lachrymalis *Fitch*
I. provancheri *VanD.*
Agallia novella *Say*
A. quadripunctata *Prov.*

Jassidae

*Platymetopius frontalis *VanD.*
Deltocephalus configuratus *Uhl.*
D. minki *Fieb.*
D. sayi *Fitch*
D. sylvestris *O.&B.*
*†D. near sylvestris 3 ex. undet.
*†D. miscellus *Ball*
Athysanus anthracinus *VanD.*
*†A. infuscatus *G.&B.*
*†A. new *sp.* near relativus
*†A. instabilis *VanD.*
*†Thamnotettix belli *Uhl.*
*†Cicadula lepida *VanD.*[1]
*Eugnathodus abdominalis *VanD*

Specimen too immature for certain identification

Corrodentia

Psocus *sp.* near hageni
Peripsocus modidus *Hag.*
P. permadidus *Hag.*
Caecilius aurantiacus *Hag.*

Typhlocybidae

Dicraneura communis *Gill.*
Empoasca atrolabes *Gill.*
*E. mali *LeBaron*
Typhlocyba rosea? *Linn.*
*†T. lethierryi *Edw.*[2]
*†Alebra *n.sp.*

Mallophaga

†Trichodectes setosus *Gieb.*? on porcupine

Psyllidae

*†Livia vernalis *Fitch*
Psylla; two species not identified

Neuroptera

†Conwentzia hageni *Banks*[3]

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[1] A rare form which Mr VanDuzee has not seen since he described it, many years ago.

[2] Gillette writing of this species in 1898 states the only native specimens that he has seen are from Michigan and Iowa. The form closely resembles T. r o s e a Linn.

[3] This species was described in 1906. The only records at hand show that it has been taken at Sea Cliff, L.I., Washington. D. C., Virginia and West Virginia.

EXPLANATION OF PLATES

PLATE I

Fly vivarium. Photo, October 1909

Plate 1

Fly vivarium

PLATE 2

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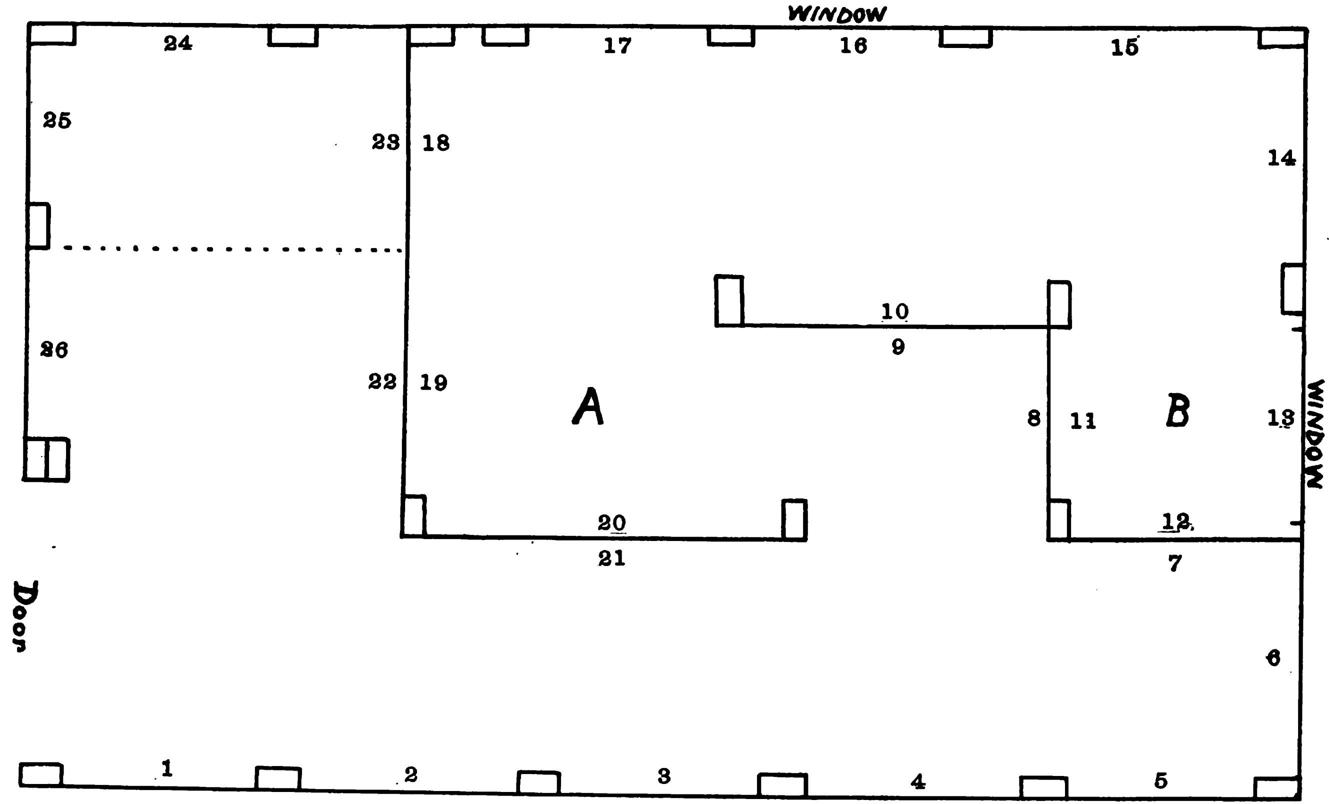
Plan of fly vivarium

Plate 2

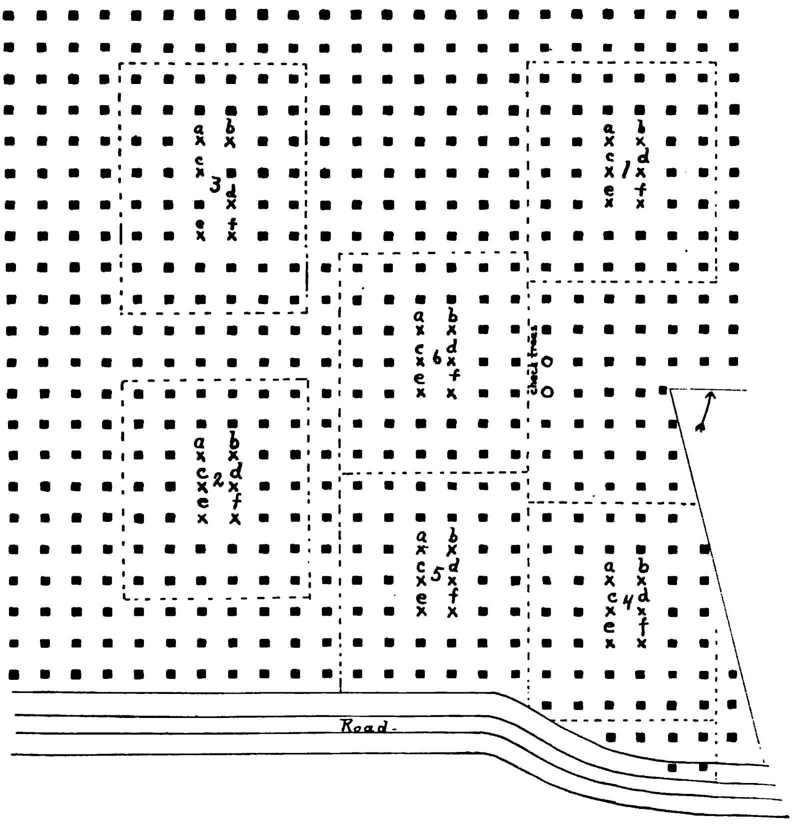


Fly vivarium, ground plan

PLATE 3

Plan of experimental orchard owned by W. H. Hart, Poughkeepsie

Plate 3



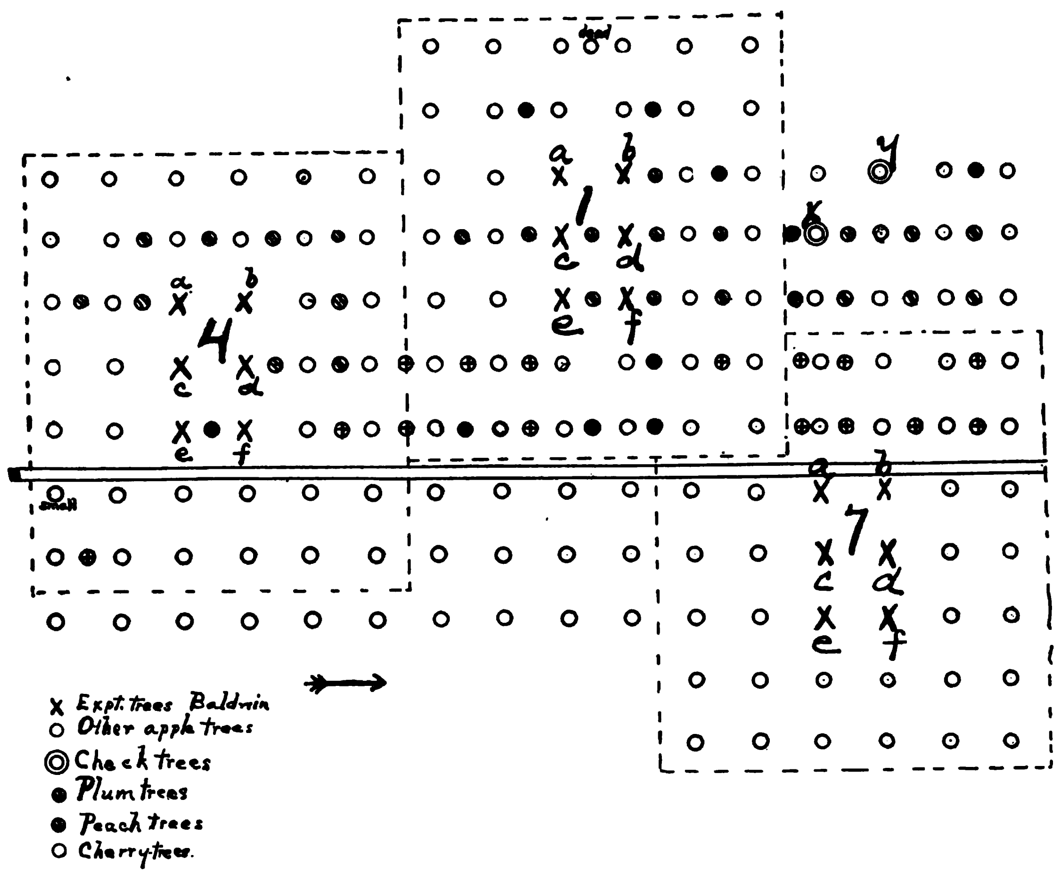
Experimental orchard, W. H. Hart, Poughkeepsie

PLATE 4

133

Plan of experimental orchard owned by Edward Van Alstyne, Kinderhook

Plate 4



Experimental orchard, Edward Van Alstyne, Kinderhook

PLATE 5

1 Experimental tree 1D
2 Experimental tree 2A
Poughkeepsie. Photo, October 1909

Plate 5

Experimental trees, 1 D (upper illustration), 2 A (lower illustration), Poughkeepsie

PLATE 6

1 Experimental tree 3B
2 Experimental tree 4B
Poughkeepsie. Photo, October 1909

Plate 6

Experimental trees, 3 B (upper illustration). 4 B (lower illustration), Poughkeepsie

PLATE 7

1 Experimental tree 5C
2 Experimental tree 6F
Poughkeepsie. Photo, October 1909

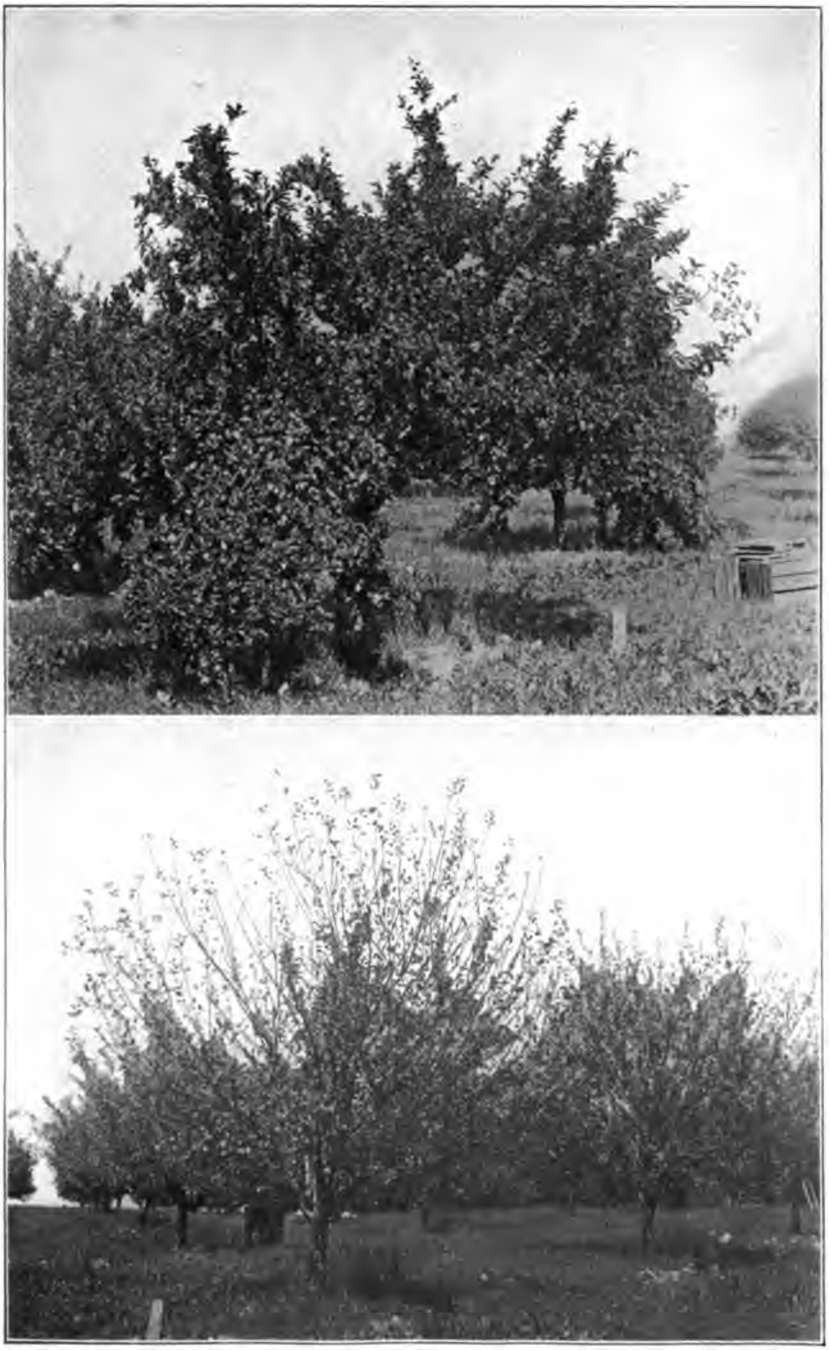
Plate 7

Experimental trees, 5 C (upper illustration), 6 F (lower illustration), Poughkeepsie

PLATE 8

1 Experimental tree X
2 Northern Spy in plot 3, note paucity of foliage
Poughkeepsie. Photo, October 1909

Plate 8



Experimental trees, X above, Northern Spy below

PLATE 9

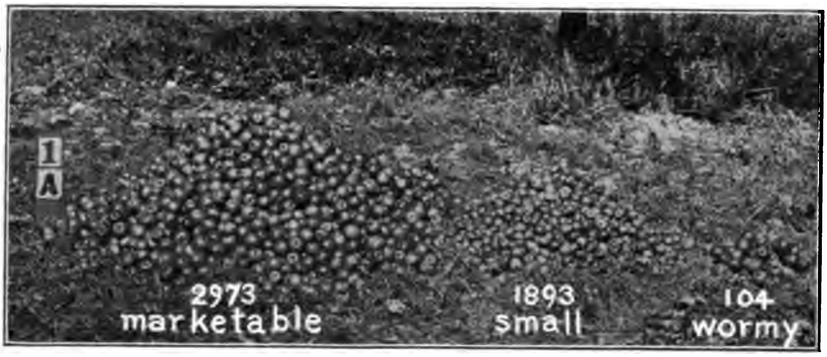
1 Apples on experimental tree 1A. 2973 marketable fruit, 1893 small fruit, 104 wormy fruit

2 Apples on experimental tree 1D. 3739 marketable fruit, 4775 small fruit, 45 wormy fruit

3 Apples on experimental tree 1E. 1375 marketable fruit, 1013 small fruit, 72 wormy fruit

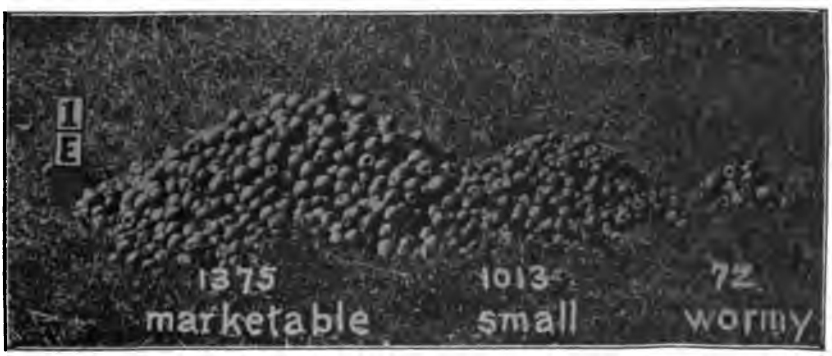
October picking, Poughkeepsie

Plate 9



1

2



3

Experimental trees, yield, Poughkeepsie

PLATE 10

145

1 Apples on experimental tree 2A. 1227 marketable fruit, 900 small fruit, 15 wormy fruit

2 Apples on experimental tree 2E. 2026 marketable fruit, 1571 small fruit, 25 wormy fruit

3 Apples on experimental tree 2F. 877 marketable fruit 256 small fruit, 18 wormy fruit

October picking, Poughkeepsie

Plate 10

1

2

3

Experimental trees, yield, Poughkeepsie

PLATE 11

1 Apples on experimental tree 3B. 324 marketable fruit, 64 small fruit 4 wormy fruit

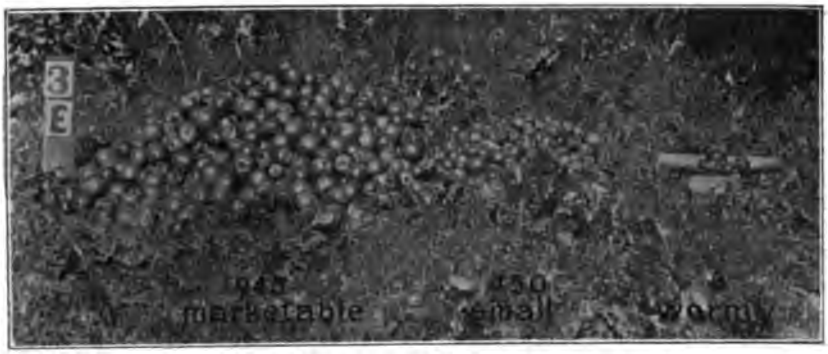
2 Apples on experimental tree 3E. 945 marketable fruit, 450 small fruit, 6 wormy fruit

3 Apples on experimental tree 3F. 1505 marketable fruit, 628 small fruit, 7 wormy fruit

October picking, Poughkeepsie

Plate 11

1



2

3

Experimental trees, yield, Poughkeepsie

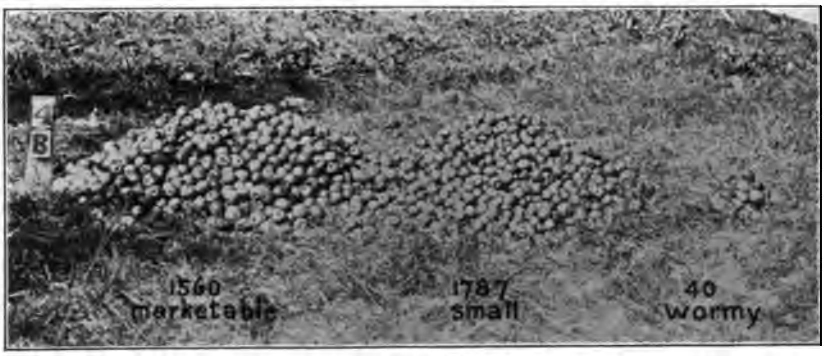
PLATE 17

149

1 Apples on experimental tree 4B. 1560 marketable fruit, 1787 small fruit, 40 wormy fruit
2 Apples on experimental tree 4D. 3989 marketable fruit, 1984 small fruit, 40 wormy fruit
3 Apples on experimental tree 4F. 2244 marketable fruit, 2726 small fruit. 41 wormy fruit

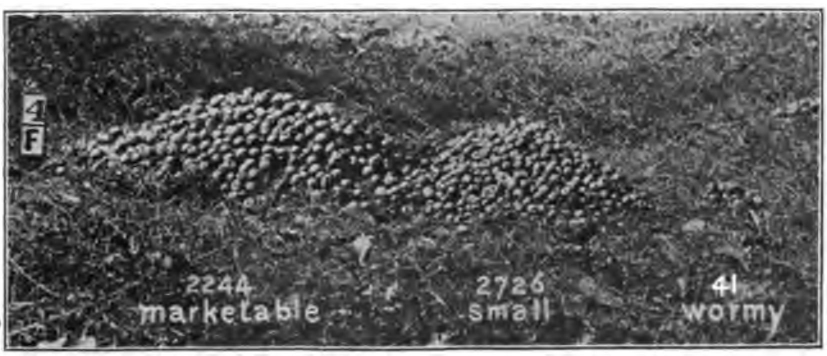
October picking, Poughkeepsie

Plate 12



1

2



3

Experimental trees, yield, Poughkeepsie

PLATE 13

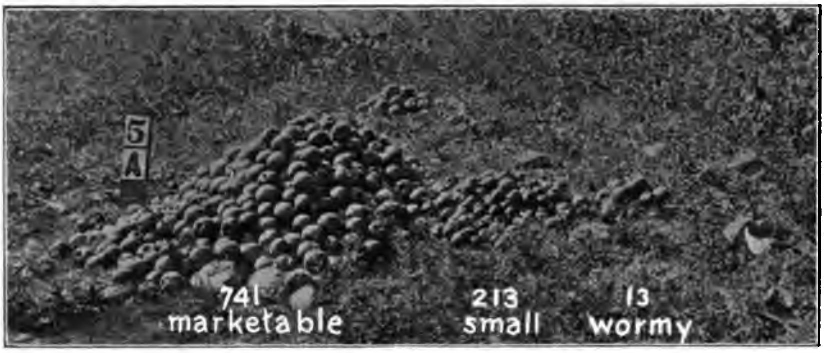
1 Apples on experimental tree 5A. 741 marketable fruit, 213 small fruit, 13 wormy fruit

2 Apples on experimental tree 5C. 1543 marketable fruit, 1773 small fruit, 21 wormy fruit

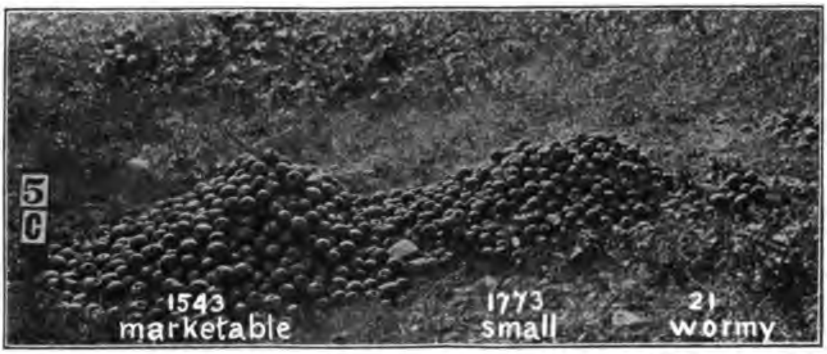
3 Apples on experimental tree 5E. 2271 marketable fruit, 1500 small fruit, 57 wormy fruit

October picking, Poughkeepsie

Plate 13



1



2

3

Experimental trees, yield, Poughkeepsie

PLATE 14

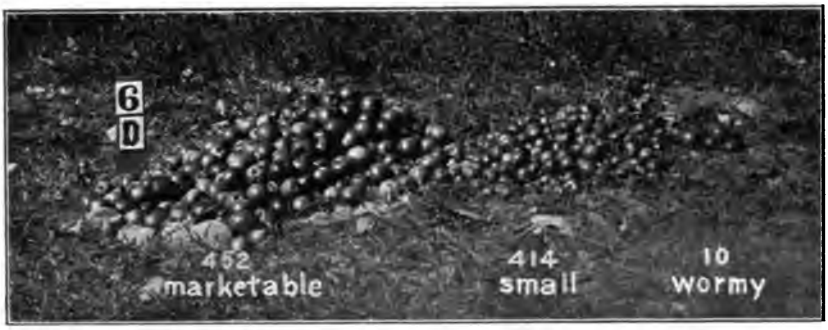
1 Apples on experimental tree 6D. 452 marketable fruit, 414 small fruit, 10 wormy fruit

2 Apples on experimental tree 6E. 2320 marketable fruit, 885 small fruit, 19 wormy fruit

3 Apples on experimental tree 6F. 417 marketable fruit, 253 small fruit, no wormy fruit

October picking, Poughkeepsie

Plate 14



1

2

3

Experimental trees, yield, Poughkeepsie

PLATE 15

1 Blossoms just ready to spray

2 Apples on check tree X. **923 marketable fruit, 973 small fruit, 493** wormy fruit

3 Apples on check tree Y. **225 marketable fruit, 186 small fruit, 166** wormy fruit

October picking, **Poughkeepsie**

Plate 15

1

2

3

1 Blossoms ready to spray,

2, 3 Experimental work, yield of check trees, Poughkeepsie

PLATE 16

1 Apples on experimental tree 1A. 2269 marketable fruit, 148 small fruit, 28 wormy fruit

2 Apples on experimental tree 1C. 1813 marketable fruit, 50 small fruit, 14 wormy fruit

3 Apples on experimental tree 1E. 3095 marketable fruit, 235 small fruit 34 wormy fruit

October picking, Kinderhook

Plate 16

1

2

3

Experimental trees, yield, Kinderhook

PLATE 17

1 Apples on experimental tree 4A. 905 marketable fruit, 200 small fruit. 17 wormy fruit

2 Apples on experimental tree 4C. 960 marketable fruit, 390 small fruit. 16 wormy fruit

3 Apples on experimental tree 4D. 1175 marketable fruit, 214 small fruit. 11 wormy fruit

Greenings, late September picking, Kinderhook

Plate 17

1

2

3

Experimental trees, yield, Kinderhook

PLATE 18

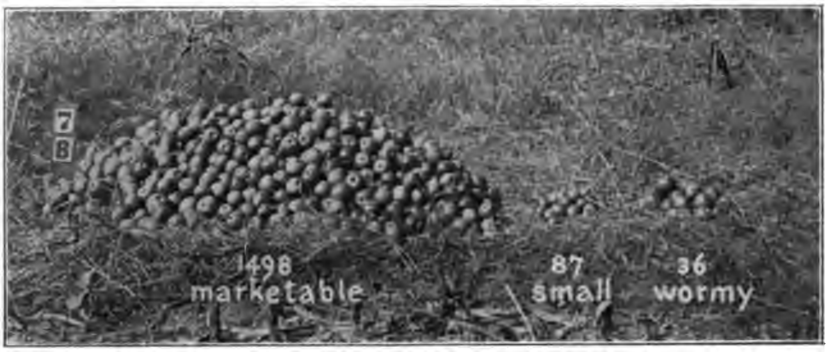
1 Apples on experimental tree 7B. 1498 marketable fruit, 87 small fruit
36 wormy fruit

2 Apples on experimental tree 7E. 2993 marketable fruit, 108 small fruit
128 wormy fruit

3 Apples on experimental tree 7F. 3907 marketable fruit, 266 small fruit
49 wormy fruit

October picking, Kinderhook

Plate 18



1

2

3

Experimental trees, yield, Kinderhook

PLATE 19

1 Blossoms after petals have fallen, showing in the sectioned blossom the space between the base of the stamens and the pistil

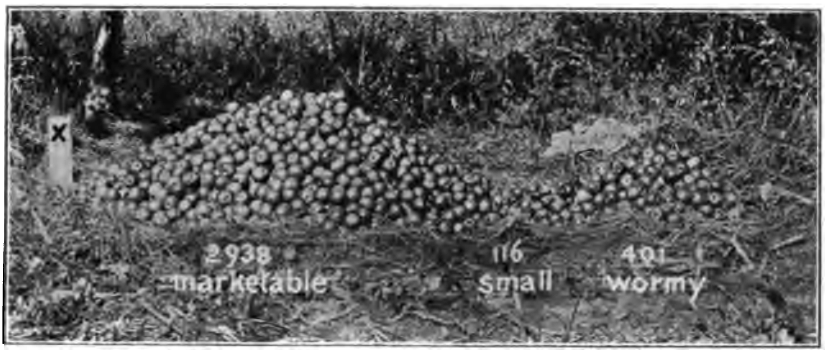
2 Apples on check tree X. 2938 marketable fruit, 116 small fruit, 401 wormy fruit

3 Apples on check tree Y. 1737 marketable fruit, 79 small fruit, 692 wormy fruit

October picking, Kinderhook

Plate 19

1



2

3

1 Blossom in section showing cavity at the base of the stamens
2, 3, Experimental work, yield of check trees, Kinderhook

PLATE 20

Upper figure, a decapitated Ben Davis in the orchard of Mr W. H. Hart at Poughkeepsie. This tree was cut back three or four years ago and is a striking illustration of the feasibility of this treatment. Photo, October 1909
Lower figure, a decapitated Baldwin in the same orchard

Plate 20

Trees in an old orchard, which has been infested by San José scale about 14 years

PLATE 21

Upper figure, a decapitated Sutton beauty in the old orchard of Mr W. H. Hart at Poughkeepsie. This tree has a remarkably fine showing of fruit. Photo, October 1909

Lower figure, a Ben Davis tree in the orchard of Mr W. H. Hart at Poughkeepsie. This tree has been infested with San José scale for 14 years and stands adjacent to the spot where the original infested tree stood. Photo, October 1909

Plate 21

Trees in an old orchard, which has been infested by San José scale about 14 years

PLATE 27

169

Characteristic nests of the brown tail moth, Euproctis chrysorrhoea Linn.

Plate 22

Characteristic nests of the brown tail moth

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Appendix 4

Botany

Museum Bulletin 139

139 Report of the State Botanist 1909

Education Department Bulletin

Published fortnightly by the University of the State of New York

Entered as second-class matter June 24, 1908, at the Post Office at Albany, N. Y., under the act of July 16, 1894

No. 470 ALBANY, N. Y. MAY 1, 1910

New York State Museum

JOHN M. CLARKE, Director
CHARLES H. PECK, State Botanist

Museum Bulletin 139

REPORT OF THE STATE BOTANIST 1909

New York State Education Department

Science Division, February 23, 1910

Hon. Andrew S. Draper LL.D.

Commissioner of Education

SIR: I have the honor to communicate herewith for publication as a bulletin of the State Museum, the report of the State Botanist for the fiscal year ending September 30, 1909.

Very respectfully

JOHN M. CLARKE

Director

State of New York
Education Department
COMMISSIONER'S ROOM

Approved for publication this 24th day of February 1910

A. S. Draper

Commissioner of Education

Education Department Bulletin

Published fortnightly by the University of the State of New York

Entered as second-class matter June 24, 1908, at the Post Office at Albany, N. Y., under the act of July 16, 1894

No. 470 | ALBANY, N. Y. | May 1, 1910

New York State Museum

John M. Clarke, Director
Charles H. Peck, State Botanist

Museum Bulletin 139

REPORT OF THE STATE BOTANIST 1909

Dr John M. Clarke, Director of State Museum:

The following report of work done in the botanical department of the State Museum for the year 1909 is respectfully submitted.

Since the date of my last report specimens of plants for the State herbarium have been collected in the counties of Albany, Columbia, Jefferson, Lewis, Livingston, Rensselaer, Steuben, St Lawrence, Warren and Wyoming. Specimens have also been added to the herbarium that were received from correspondents and others. These were collected in the counties of Albany, Cayuga, Dutchess, Essex, Franklin, Herkimer, Monroe, New York, Oneida, Onondaga, Ontario, Orleans, Oswego, Queens, Rensselaer, Schoharie, Suffolk, Tompkins, Ulster, Warren and Washington.

The number of species of which specimens have been added to the herbarium is 255 of which 56 species were not before represented in it. Of these, 11 are considered new or hitherto undescribed species. All except one are fungi. The specimens of the 199 species not new to the herbarium serve to give a better or more complete representation of their respective species than was given before. A list of the names of all the added species is given under the title "Plants added to the herbarium."

The number of those reported as contributors to the herbarium is 66. Some of these have sent specimens for identification merely, but when the specimens were collected in this State and were received in good condition, if the species was previously unrepresented in the herbarium or if for any other reason they were deemed worthy of preservation, they have been preserved and credited to the sender as a contribution to the herbarium

Some of our best and most interesting additions to the herbarium have been made in this way. The names of contributors of such specimens and of extralimital specimens with their respective contributions are given under the title " Contributors and their contributions."

The number of species added to our New York flora is 77. Several of these have been reported before as varieties of other species or confused with other species, but having been recently admitted in Gray's New Manual as distinct species it has been thought best to record them as such with their known New York localities. The names of these and other added species together with their localities, descriptions of new species, and other matters of interest will be found under the title " Species not before reported." Under the heading " Remarks and observations " any facts of interest concerning the species mentioned are recorded. This record may include new varieties of plants or notable variations, new localities for rare plants, and remarks concerning the diseases of plants or their economic properties.

The work of testing our wild mushrooms for their edible qualities as opportunity was given has been continued. Five species have been personally tested and approved as edible. These, added to the species and varieties previously known, make the number of New York species and varieties now known to be edible 200. Plain and simple descriptions of the newly added species are given under the title " Edible fungi." Colored figures of these species may be found on plates 117–20. Among the extralimital contributed specimens 10 apparently new species are represented. Descriptions of these species are given in a part of the report marked " New species of extralimital fungi." Colored figures of six of these species may be found on plates W, X, Y and Z.

Revised descriptions of our New York species of the genera Inocybe and Hebeloma have been prepared, with keys to the sections or subgenera and to the species. It is believed that these simple localized monographs will be helpful to those studying or desiring to study these interesting subjects of the vegetable kingdom. These chapters are respectively entitled " New York species of Inocybe " and " New York species of Hebeloma."

The climatic character of the season has been to a large extent a repetition of that of 1908. A cold late spring, an unusually dry summer and prevailing cool weather were its characteristic

features. These conditions were decidedly unfavorable to wild mushroom growth. Scarcely any could be found except the few that naturally inhabit swamps and low wet ground in woods. In the latter part of the season gentle rains moistened the surface of the ground sufficiently to insure the development of good agricultural crops and a fair seasonable crop of some mushrooms. But the effect upon the common mushroom, Agaricus campester and its variety, the garden mushroom, Agaricus campester hortensis, is worthy of special notice. In the vicinity of Albany a gentle and prolonged rain, the latter part of August, moistened the surface of the ground quite effectually. In a few days the common mushroom appeared in unusual abundance, though it was a little earlier in the season than it usually appears. The mushrooms were so plentiful that at least one fruit dealer offered them for sale in quart baskets at his fruit stand. A few weeks later light showers were followed by a copious crop of the "garden mushroom," a form differing from the common mushroom in having its cap adorned with brownish fibrils which form small spotlike scales on it and give it a darker color than that of the white form of the common mushroom. This crop continued to develop freely for several days and grew in some instances in pastures of light sandy soil where mushrooms are not usually expected to grow. The same abundant appearance of the edible mushroom was reported to have followed the light autumnal showers in other localities in the State. The lesson it teaches is that for mushroom production gentle showers are better than torrents of rain.

The number of those who have sent or brought specimens of plants to the office of the botanist for identification is 152. The number of identifications made is 1717.

Mr S. H. Burnham, my assistant, in addition to his other duties, has prepared a list of the names of the edible, poisonous and unwholesome species of mushrooms hitherto figured and described in the publications of the museum, together with the citations of the time and place of publication of each. He has also prepared a list of the genera of fungi of which the New York species (chiefly) have been described as far as known in previous reports. The time and place of these limited monographic publications are cited. Both these lists may be found at the end of this report.

CHARLES H. PECK
State Botanist

Albany, December 24, 1909

PLANTS ADDED TO THE HERBARIUM

New to the herbarium

Ascochyta solani-nigri *Diedicke*
Belonidium glyceriae *Pk.*
Biatora cupreo-rosella (*Nyl.*) *Tuckm.*
Bidens tenuisecta *Gray*
Boletus viridarius *Frost*
Carduus crispus *L.*
Chaenactis stevioides *H. & A.*
Ciboria luteo-virescens *R. & D.*
Clitocybe candida *Bres.*
Cortinarius subsalmoneus *Kauf. Ms.*
Crataegus brevipes *Pk.*
C. efferata *S.*
C. letchworthiana *S.*
Diplocladium penicilloides *Sacc.*
Diplodia cercidis *E. & E.*
D. hamamelidis *Fairm.*
D. tamariscina *Sacc.*
Dothiorella divergens *Pk.*
Epipactis tesselata (*Lodd.*) *Eaton*
Fenestella amorpha *E. & E.*
Hypholoma boughtoni *Pk.*
H. rigidipes *Pk.*
Leontodon nudicaulis (*L.*) *Banks*
Ligusticum scoticum *L.*
Lophiotrema hysterioides *E. & E.*
L. littorale *Speg.*
Marasmius alienus *Pk.*
Melanopsamma confertissima (*Plow.*)
Microcera coccophila *Desm.*
Midotis irregularis (*Schw.*)
Monolepis nuttalliana (*R. & S.*)
Morchella crispa *Karst.*
M. rimosipes *DC.*
Nardia crenulata (*Sw.*) *Lindb.*
N. hyalina (*Lyell*) *Carr.*
Peridermium strobi *Kleb.*
Pezizella lanc.-paraphysata *Rehm*
Phaeopezia fuscocarpa (*E. & H.*)
Pholiota aurivella *Batsch*
Phomopsis stewartii *Pk.*
Picris echinoides *L.*
Polyporus giganteus (*Pers.*) *Fr.*
Psilocybe nigrella *Pk.*
Puccinia epiphylla (*L.*) *Wettst.*
Ribes trist. albinervium (*Mx.*)
Rubia tinctorum *L.*
Rumex pallidus *Bigel.*
Schwalbea americana *L.*
Septoria sedicola *Pk.*
Solidago aspera *Ait.*
Sparganium diversifolium *Graeb.*
Stachys sieboldii *Miq.*
Stephanoma strigosum *Wallr.*
Trametes merisma *Pk.*
Verticillium rexianum *Sacc.*
Volvaria volvacea (*Bull.*) *Fr.*

Not new to the herbarium

Agaricus campester *L.*
A. silvicola *Vitt.*
Agropyrum tenerum *Vasey*
Alnus crispa (*Ait.*) *Pursh*
Amanita frostiana *Pk.*
A. phalloides *Fr.*
Anagallis arvensis *L.*
Angelica atropurpurea *L.*
Antennaria brainerdi *Fern.*
Anthemis cotula *L.*
Arcyria cinerea (*Bull.*) *Pers.*
A. punicea *Pers.*
Arenaria peploides *L.*
Arisaema dracontium (*L.*) *Schott*
Aristida gracilis *Ell.*
Armillaria mellea *Vahl*
Aster ericoides *L.*
A. puniceus *L.*
Atriplex pat. littoralis (*L.*)
Barbarea vulgaris *R. Br.*
Bidens beckii *Torr.*
Boehmeria cylindrica (*L.*) *Sw.*
Bromus altissimus *Pursh*
Caldesiella ferruginosa (*Fr.*)
Calvatia elata (*Mass.*) *Morg.*
C. gigantea (*Batsch*)
Cantharellus infundibuliformis (*Scop.*)
Cardamine bulbosa (*Schreb.*)

Cardamine douglassii (*Torr.*)
Carduus spinosissimus (*Walt.*)
Carex bebbii *Olney*
C. crawfordii *Fern.*
Centaurea solstitialis *L.*
Cerastium viscosum *L.*
Cladosporium typhae *Schw.*
Collybia myriadophylla *Pk.*
C. platyphylla *Fr.*
C. radicata (*Relh.*) *Fr.*
Convallaria majalis *L.*
Coprinus atramentarius (*Bull.*)
C. micaceus (*Bull.*)
Cornus amomum *Mill.*
Corallorrhiza trifida *Chat.*
Crataegus acclivis *S.*
C. anomala *S.*
C. beata *S.*
C. eatoniana *S.*
C. ellwangeriana *S.*
C. grayana *Eggl.*
C. halliana *S.*
C. holmesiana *Ashe*
C. ignea *S.*
C. maineana *S.*
C. menandiana *S.*
C. ovatifolia *S.*
C. persimilis *S.*
C. polita *S.*
C. punctata *Jacq.*
C. repulsans *S.*
C. rotundifolia *Moench*
C. succulenta *Lk.*
C. tenuiloba *S.*
Crepidotus applanatus (*Pers.*)
C. malachius *B. & C.*
Cuscuta arvensis *Beyrich.*
C. cephalanthi *Engelm.*
Cypripedium acaule *Ait.*
Cystopus candidus (*Pers.*) *Lev.*
Daedalea unicolor (*Bull.*) *Fr.*
Erysiphe cichoracearum *DC.*
Erythronium albidum *Nutt.*
Eupatorium purpureum *L.*
Exidia gland. levior *Sacc.*
Exoascus confusus *Atk.*
E. pruni *Fckl.*
E. unilateralis *Pk.*
Fagopyrum tataricum (*L.*) *Gaertn.*
Favolus europaeus *Fr.*
Fimbrystilis castanea (*Mx.*) *Vahl*
Flammula pulchrifolia *Pk.*
Fuligo septica (*Lk.*) *Gmel.*
Fusicladium destruens *Pk.*
Galera lat. albicolor *Pk.*
Galium erectum *Huds.*
Geranium pusillum *Burm. f.*
Geum flavum (*Port.*) *Bickn.*
Gloeoporus conchoides *Mont.*
Hedeoma hispida *Pursh*
Helenium autumnale *L.*
Hieracium florentinum *All.*
H. gronovii *L.*
H. scabrum *Mx.*
Hybanthus concolor (*Forst.*)
Hypericum canadense *Mx.*
Hypochaeris radicata *L.*
Ilex vert. tenuifolia (*Torr.*) *Wats.*
Iris prismatica *Pursh*
Irpex obliquus (*Schrad.*) *Fr.*
Juncus brachycephalus (*Engelm.*)
J. brevicaudatus (*Engelm.*)
J. secundus *Beauv.*
Juniperus com. depressa *Pursh*
J. horizontalis *Moench*
Lactarius aquifluus *Pk.*
L. glyciosmus *Fr.*
Lactuca scar. integrata *G. & G.*
Laportea canadensis (*L.*) *Gaud.*
Lappula virginiana (*L.*) *Greene*
Leonurus cardiaca *L.*
Listera australis *Lindl.*
Lycoperdon gemmatum *Batsch*
Marasmius acerinus *Pk.*
M. glabellus *Pk.*
M. oreades *Fr.*
Monilia crataegi *Diedicke*
Morus rubra *L.*
Mycena pelianthina *Fr.*
M. pseudopoda (*Pers.*)
M. pseudopura *Cke.*
M. sanguinolenta *A. & S.*
Myosotis virginica (*L.*) *B. S. P.*
Naias gracillima (*A. Br.*) *Magn.*
Oenothera linearis *Mx.*
Omphalia rugosodisca *Pk.*
Onopordon acanthium *L.*
Panicum implicatum *Scribn.*
P. oricola *H. & C.*
P. spretum *Schultes*

Paxillus involutus (*Batsch*) *Fr.*
Peridermium consimile *A. & K.*
Phlox divaricata *L.*
Pholiota angustipes *Pk.*
P. vermiflua *Pk.*
Pilea pumila (*L.*) *Gray*
Plantago decipiens *Braineoud*
Pleurotus ulmarius (*Bull.*) *Sow.*
Pluteus admirabilis *Pk.*
P. cervinus (*Schaeff.*) *Fr.*
P. granularis *Pk.*
P. nanus (*Pers.*) *Fr.*
Polygonum avic. littorale (*Lk.*)
Polyporus elegans *Fr.*
P. sulphureus (*Bull.*) *Fr.*
Potamogeton richardsoni (*Benn.*)
Prunus pumila *L.*
Puccinia coronata *Cda.*
P. rubigo-vera (*DC.*) *Wint.*
P. veratri *Niessl.*
Pyrus coronaria *L.*
P. melanocarpa (*Mx.*) *Willd.*
Quercus macrocarpa *Mx.*
Radicula pal. hispida (*Desv.*)
Ranunculus delphinifolius *Torr.*
R. reptans *L.*
Roestelia aurantiaca *Pk.*
Rubus andrewsianus *Blanch.*
R. permixtus *Blanch.*
R. recurvans *Blanch.*
Russula brevipes *Pk.*
R. lepida *Fr.*
R. mariae *Pk.*
Sanicula canadensis *L.*
Sedum ternatum *Mx.*
Silybium marianum (*L.*) *Gaertn.*
Sisymbrium altissimum *L.*
S. sophia *L.*
Solanum dulcamara *L.*
S. nigrum *L.*
Solidago neglecta *T. & G.*
S. squarrosa *Muhl.*
Sparganium americanum *Nutt.*
S. angustifolium *Mx.*
Spiraea latifolia *Borkh.*
Stachys arenicola *Britton*
Suaeda maritima (*L.*) *Dumort.*
Thalictrum confine *Fern.*
T. dasycarpum *F. & L.*
T. revolutum *DC.*
Thelephora terrestris *Ehrh.*
Trametes suaveolens (*L.*) *Fr.*
Tricholoma album (*Schaeff.*) *Fr.*
Trichothecium roseum (*Pers.*) *Lk.*
Trillium grand. variegatum *Pk.*
Tripsacum dactyloides *L.*
Urtica lyellii *Wats.*
Ustilago longissima (*Sow.*) *Tul.*
Ustulina vulgaris *Tode*
Vaccinium pennsylvanicum *Lam.*
Veronica humifusa *Dicks.*
V. tournefortii *Gmel.*
Verticillium lactarii *Pk.*
Vicia angustifolia (*L.*) *Reich.*
Viola rafinesquii *Greene*
V. renifolia *Gray*
V. sororia *Willd.*
V. triloba *Schw.*
Vitis vulpina *L.*
Zizania palustris *L.*
Zizia aurea (*L.*) *Koch.*

CONTRIBUTORS AND THEIR CONTRIBUTIONS

Miss L. C. Allen, Newtonville, Mass.
Bovistella ohiensis *E. & M.*

Miss H. C. Anderson, Lambertville, N. J.
Morchella gigas (*Batsch*) *Fr.*

Miss F. Beckwith, Rochester
Bidens tenuisecta *Gray*
Chaenactis stevioides *H. & A.*
Erodium cicutarium (*L.*) *L'Her.*
Geranium pusillum *Burm. f.*
Monolepis nuttalliana (*R. & S.*)
Sisymbrium sophia *L.*
Viola sororia *Willd.*

Mrs E. B. Blackford, Boston, Mass.

Cortinarius acutoides *Pk.*
C. lutescens *Pk.*
Lactarius hysginus *Fr.*
Russula blackfordae *Pk.*
Russula serissima *Pk.*

Mrs H. C. Davis, Falmouth, Me.

Bovista pila *B. & C.*
Crucibulum vulgare *Tul.*
Mutinus caninus (*Huds.*) *Fr.*
Rhizina inflata (*Schaeff.*) *Quel.*
A set of colored drawings representing about 150 species of fleshy fungi from Maine

Mrs E. P. Gardner, Canandaigua

Trillium grandiflorum variegatum *Pk.*

Mrs L. L. Goodrich, Syracuse

Arisaema dracontium (*L.*) *Schott*
Sisymbrium altissimum *L.*
Veronica tournefortii *C. C. Gmeln.*

Mrs C. W. Harris, Washington, D. C.

Baeomyces roseus *Pers.*
Cetraria oakesiana *Tuckm.*
Cladonia caespiticia (*Pers.*) *Fl.*
C. cristatella *Tuckm.*
C. mitrula *Tuckm.*
C. papillaria (*Ehrh.*) *Hoffm.*
C. pyxidata (*L.*) *Fr.*
C. rangiferina (*L.*) *Hoffm.*
C. verticillata *Fr.*
Parmelia borreri rudecta *Tuckm.*
P. caperata (*L.*) *Ach.*
P. conspersa (*Ehrh.*) *Ach.*
P. perlata (*L.*) *Ach.*
P. physodes (*L.*) *Ach.*
P. saxatilis (*L.*) *Fr.*
Peltigera aphthosa (*L.*) *Hoffm.*
Peltigera canina (*L.*) *Hoffm.*
P. polydactyla (*Neck.*)
Physcia aquila detonsa *Tuckm.*
P. caesia (*Hoffm.*) *Nyl.*
P. obscura (*Ehrh.*) *Nyl.*
P. obsc. endochrysea *Nyl.*
P. stellaris (*L.*) *Tuckm.*
P. stell. aipolia *Nyl.*
Pyxine sorediata *Fr.*
Ramalina calic. fastigiata *Fr.*
Sticta amplissima (*Scop.*) *Mass.*
S. pulmonaria (*L.*) *Ach.*
Umbilicaria dillenii *Tuckm.*
U. muhlenbergii (*Ach.*)
Umbilicaria pustulata papulosa *Tuckm.*

Miss A. Hibbard, West Roxbury, Mass.

Boletinus glandulosus *Pk.*
Boletus miniato-olivaceus *Frost*
Gomphidius nigricans *Pk.*
Stropharia depilata *Pers.*
Tricholoma acre *Pk.*

Miss D. Hone, Minneapolis, Minn.

Polyporus isidioides *Berk.*
Polyporus obtusus *Berk.*

Miss A. Lorenz, Hartford, Conn.

Marsupella robusta (*DeNot.*) *Evans*
M. sullivantii (*DeNot.*)
Nardia crenulata (*Sm.*) *Lindb.*
N. hyalina (*Lyell*) *Carr.*

Miss H. L. Palliser, Poughkeepsie

Boletus viridarius *Frost*

Dr C. E. Putnam, St Paul, Minn.
Secotium acuminatum *Mont.*

Miss M. L. Sutliff, Sacramento, Cal.
Rhizopogon rubescens *Tul.*

Mrs M. E. Williams, Wernersville, Pa.
Leskea gracilescens *Hedw.*

J. C. Arthur, Lafayette, Ind.
Puccinia grindeliae *Pk.*

A. D. Baker, Auburn
Centaurea solstitialis *L.*

C. F. Baker, Claremont, Cal.

Agaricus bivelatus *Pk.*
A. solidipes *Pk.*
A. subnitens *Pk.*
Amanita bivolvata *Pk.*
A. calyptratoides *Pk.*
A. ocreata *Pk.*
A. virosa *Fr.*
Amanitopsis velosa *Pk.*
Armillaria subannulata *Pk.*
Boletus tomentipes *Earle*
Clitocybe microspora *Pk.*
C. sphaerospora *Pk.*
Collybia albogrisea *Pk.*
Coprinus calyptratus *Pk.*
Cortinarius multiformis *Fr.*
Hebeloma foedatum *Pk.*
H. ischnostylum *Cke.*
Hypholoma campanulata *Pk.*
H. cutifracta *Pk.*
Inocybe bakeri *Pk.*
I. bulbosa *Pk.*
Lactarius rufulus *Pk.*
L. theiogalus (*Bull.*)
Leptonia edulis *Pk.*
Mycena atroalboides *Pk.*
M. elegantula *Pk.*
M. haematopoda (*Pers.*) *Fr.*
Naucoria platysperma *Pk.*
N. vinicolor *Pk.*
Pluteolus luteus *Pk.*
Psathyrella graciloides *Pk.*
Psilocybe castanella *Pk.*
Russula semicrema *Fr.*
Tricholoma equestre (*L.*) *Fr.*
Tubaria furfuracea (*Pers.*) *Fr.*

H. J. Banker, Greencastle, Ind.

Onygena equina *Pers.*
Polyporus sulphureus (*Bull.*) *Fr.*
Xylaria pedunculata (*Dicks.*) *Fr.*

H. W. Barratt, Poughkeepsie
Coprinus atramentarius (*Bull.*) *Fr.*

E. Bartholomew, Stockton, Kan.

Barlaea subaurantia *B. & R.*
Bjerkandera adusta (*Willd.*) *Karst.*
Botrytis uredinicola *Pk.*
Bubakia crotonis (*Cke.*) *Arth.*
Ceratophorum uncinatum (*Clint.*)
Cercospora biformis *Pk.*
C. brunnea *Pk.*
C. flagellaris *E. & M.*
C. fuscovirens *Sacc.*
C. mississippiensis *T. & E.*
C. rhoina *C. & E.*
C. rubi *Sacc.*
C. simulata *E. & E.*
C. sordida *Sacc.*
C. vignae *E. & E.*
Clavaria aurea *Schaeff.*
Coleosporium elephantopodis (*Schw.*)
C. ipomoeae (*Schw.*) *Burr.*
C. laciniariae *Arth.*
C. solidaginis (*Schw.*)
C. vernoniae *B. & C.*
Coriolus prolificans (*Fr.*) *Murr.*
C. versicolor (*L.*) *Quel.*
Corticium roseolum *Mass.*
Cylindrosporium padi *Karst.*
Daedalea aesculi (*Schw.*) *Murr.*
Darluca filum (*Biv.*) *Cast.*
Diatrype stigma (*Hoffm.*) *Fr.*
Fusarium bartholomaei *Pk.*
F. juglandinum *Pk.*
Ganoderma curtisii (*Berk.*) *Murr.*
Gyroceras divergens *Pk.*
Hapalopilus gilvus (*Schw.*) *Murr.*
Helminthosporium hamatellum *Pk.*
Herpotrichia rhodospiloides *Pk.*
Hirneola auricula-judae (*L.*)
Hydnoporia fuscescens (*Schw.*) *Murr.*
Hypoxylon multiforme *Fr.*
Irpiciporus lacteus (*Fr.*) *Murr.*
Kuehneola albida (*Kuehn.*) *Magn.*
Lenzites betulina (*L.*) *Fr.*
Lycoperdon atropurpureum *Vitt.*
L. pulcherrimum *B. & C.*
Melampsora bigelowii *Thuem.*
M. medusae *Thuem.*
Microsphaera alni (*Wallr.*) *Salm.*
Nectria cinnabarina (*Tode*) *Fr.*
Nummularia repanda (*Fr.*) *Nits.*
Ozonium auricomum *Link*
Peniophora quercina (*Fr.*) *Cke.*
Phlebia radiata *Fr.*
Phyllosticta smilacis *E. & M.*
Piggotia fraxini *B. & C.*
Pileolaria toxicodendri (*B. & R.*)
Puccinia helianthi *Schw.*
P. lateripes *B. & R.*
P. lobeliae *Ger.*
P. menthae americana *Pk.*
P. Muhlenbergiae *A. & H.*
P. polygoni-amphibii *Pers.*
P. smilacis *Schw.*
P. xanthii *Schw.*
Pucciniastrum agrimoniae (*Schw.*)
P. hydrangeae (*B. & C.*)
P. myrtilli (*Schw.*)
Rhysotheca halstedii (*Farl.*)
Schizophyllum commune *Fr.*
Scleroderma tenerum *B. & C.*
Septoria musiva *Pk.*
S. populi *Desm.*
S. rubi *West.*
S. scrophulariae *Pk.*
Sorosporium ellisii *Wint.*
Sphaerella fraxinicola (*Schw.*)
Sphaeria potentillae *Schw.*
Stereum acerinum nivosum *Berk.*
S. complicatum *Fr.*
S. curtisii *Berk.*
S. spadiceum *Fr.*
S. versicolor (*Sw.*) *Fr.*
Stigmina platani (*Fckl.*) *Sacc.*
Thelephora rosella *Pk.*
Tranzschelia punctata (*Pers.*)
Uncinula parvula *C. & P.*
Uromyces andropogonis *Tracy*
U. appendiculatus (*Pers.*)
U. aristidae *E. & E.*
U. euphorbiae *C. & P.*
U. hedysari-paniculata (*Schw.*)
U. lespedezae (*Schw.*) *Pk.*
U. spermacocis (*Schw.*) *Curt.*
Valsaria nigrospora (*Pk.*) *B. & V.*

J. B. Bartlett, Albany

Sterigmatocystis ochracea (*Wilh.*) *VanTigh.*

F. S. Boughton, Pittsford

Hypholoma boughtoni *Pk.*
Volvaria volvacea (*Bull.*) *Fr.*

S. H. Burnham, Sandy Hill

Alnus crispa (*Ait.*) *Pursh*
Anthemis cotula *L.*
Aster divaricatus *L.*
A. macrop. velutinus *Bu.*
Carduus crispus *L.*
Ceratiomyxa fruticulosa (*Muell.*)
Cladosporium herbarum (*Pers.*) *Fr.*
Clitocybe candida *Bres.*
C. trullisata *Ellis*
Collybia platyphylla *Fr.*
Coprinus insignis *Pk.*
Corticium cremicolor *B. & C.*
C. lacteum *Fr.*
Cortinarius rimosus *Pk.*
C. subsalmoneus *Kauff. Ms.*
C. validipes *Pk.*
Diplocladium penicilloides *Sacc.*
Eutypella cerviculata (*Fr.*) *Sacc.*
Flammula pulchrifolia *Pk.*
F. spumosa *Fr.*
Fomes pinicola (*Sw.*) *Fr.*
Geum flavum (*Port.*) *Bickn.*
Gloeosporium irregulare *Pk.*
Helvella palustris *Pk.*
Hydnum laciniatum *Leers*
Hypocrea aurantiaca *Pk.*
Hypomyces lactifluorum (*Schw.*)
H. torminosus (*Mont.*) *Tul.*
Julella monosperma (*Pk.*) *Sacc.*
Lactarius cinereus *Pk.*
L. subdulcis (*Bull.*) *Fr.*
Lecanora rubina (*Vill.*) *Ach.*
Massaria vomitoria *B. & C.*
Peridermium conorum-piceae (*Rees*)
Peronospora parasitica (*Pers.*)
Piggotia astroidea *B. & Br.*
Polyporus chioneus *Fr.*
Psilocybe uda (*Pers.*) *Fr.*
Pucciniastrum potentillae *Kom.*
Rubia tinctorum *L.*
Rubus permixtus *Blanch.*
Russula aeruginea *Fr.*
R. decolorans *Fr.*
Sanicula canadensis *L.*
Sparganium diversifolium *Griseb.*
Stachys arenicola *Britt.*
S. sieboldii *Miq.*
Trametes sepium *Berk.*
T. suaveolens (*L.*) *Fr.*
Tricholoma transmutans *Pk.*
Vaccinium pennsylvanicum *Lam.*
Zygodesmus fuscus *Corda*

I. O. Cross, Hoosick Falls

Fusicladium dendriticum (*Wallr.*) *Fckl.*

S. Davis, Boston, Mass.

Clavaria lavendula *Pk.*
C. pallescens *Pk.*
Clitocybe brumalis *Fr.*
C. compressipes *Pk.*
Clitopilus davisii *Pk.*
Eccilia watsoni *Pk.*
Entoloma griseo-cyaneum *Fr.*
E. sericeum *Fr.*
E. variabile *Pk.*
Galera later. albicolor *Pk.*
Gomphidius maculatus (*Scop.*) *Fr.*
Inocybe hiulca *Fr.*
I. infelix brevipes *Pk.*
Marasmius varicosus *Fr.*
Mycena pseudopura *Cke.*
Naucoria firma *Pk.*
N. sphagnophila *Pk.*
Nolanea conica *Pk.*
Omphalia pyxidata (*Bull.*) *Fr.*
Pholiota autumnalis *Pk.*

J. Dearness, London, Can.

Clasterosporium caricinum *Schw.*
Entyloma linariae *Schroet.*
Hypocrella hypoxylon (*Pk.*)
Isariopsis albo-rosella (*Desm.*)
Leptothyrium punctiforme *B. & C.*
Marsonia potentillae (*Desm.*)
Microstroma juglandis (*Bereng.*)
Peridermium conorum-piceae (*Rees*)
Puccinia caricis-asteris *Arth.*
Sphaerotheca humuli (*DC.*) *Burr.*

F. Dobbin, Shushan

Hedeoma hispida *Pursh*
Stellaria borealis *Bigel.*

C. J. Elting, Highland

Centaurea solstitialis *L.*

C. E. Fairman, Lyndonville

Belonidium glyceriae *Pk.*
Cantharellus floccosus *Schw.*
Ciboria luteo-virescens *R. & D.*
Diplodia cercidis *E. & E.*
D. hamamelidis *Fairm.*
D. tamariscina *Sacc.*
Fenestella amorpha *E. & E.*
Helotium salicellum *Fr.*
Lycogala flavo-fuscum (*Ehrh.*) *Rost.*
Lophiotrema hysterioides (*E. & L.*)
Lophiotrema littorale *Speg.*
Melanopsamma confertissima (*Plow.*)
Microsphaera diffusa *C. & P.*
Ovularia obliqua (*Cke.*) *Oud.*
Pezizella lanc.-paraphysata *Rehm*
Phialea scutula (*Pers.*) *Gill.*
Polyporus sulphureus (*Bull.*) *Fr.*
Puccinia epiphylla (*L.*) *Wettst.*
Stephanoma strigosum *Wallr.*
Trichosporium variabile *Pk.*

G. C. Fisher, DeFuniak Springs, Fla.

Bovistella floridensis *Pk.*
Peridermium pyriforme *Pk.*

W. P. Fraser, Pictou, Can.

Calicium lenticulare (*Hoffm.*) *Ach.*
Cenangium populneum (*Pers.*) *Rehm*
Dothidella kalmiae (*Pk.*) *Sacc.*
Gnomoniella coryli (*Batsch*) *Sacc.*
Lycopodium sabinaefolium *Willd.*
L. sitchense *Rupr.*
Ramularia dubia *Riess*
Septogloeum salicinum (*Pk.*) *Sacc.*
Venturia pulchella *C. & P.*

C. Gaffin, Utica

Volvaria bombycina (*Pers.*) *Fr.*

H. Garman, Lexington, Ky.

Pholiota vermiflua *Pk.*

S. J. Greenfield, Ilion

Panaeolus retirugis *Fr.*

J. G. Grossenbacher, Geneva

Cryptosporium cerasinum *Pk.*

M. E. Hard, Kirkwood, Mo.

Laternea columnata *Nees*

E. T. Harper, Chicago, Ill.

Corticium mutatum *Pk.*
Diaporthe aucupariae *Hazsl.*
Diplodina fusispora *Pk.*
Dothiorella celastri *Pk.*
Fusarium pyrochroum (*Desm.*) *Sacc.*
Helminthosporium macrocarpum *Grev.*
Macrophoma samaricola *Sacc.*
Myxosporium acerinum *Pk.*
Phoma lebiseyi *Sacc.*
P. menispermi *Pk.*
P. platysperma *Pk.*
Sphaeropsis simillima *Pk.*
Stagonospora linearis *Pk.*
Stemphylium macrosporoideum (*B. & C.*)

O. Hill, Boston, Mass.

Agaricus halophilus *Pk.*
Hypholoma rigidipes *Pk.*.
Tricholoma subcinereum *Pk.*

G. T. Howell, Rockville, Ind.

Flammula praecox *Pk.*
Flammula pulchrifolia *Pk.*
Lepiota granosa *Morg.*

G. Jericho, Albany

Calvatia cyathiformis (*Bosc*) *Morg.*

C. E. Jones, Albany

Prunus pumila *L.*

M. E. Jones, Salt Lake City, Utah

Actinonema rosae (*Lib.*) *Fr.*
Ascochyta colorata *Pk.*
Cylindrosporium padi cerasinum (*Pk.*)
C. simile *Pk.*
Dimerosporium collinsii (*Schw.*)
Doassansia alismatis (*Nees*)
D. sagittariae (*West.*)
Erysiphe polygoni *DC.*
Linospora brunellae *E. & E.*
Macrosphaera alni ludens *Salm.*
M. diffusa *C. & P.*
Phyllosticta angelicae *Sacc.*
Physoderma vagans *Schroet.*
Septoria sacch. occidentalis *E. & E.*
S. sorbi *Lasch*
S. streptopodis *Pk.*
Sphaerotheca humuli (*DC.*) *Burr.*

R. Latham, Orient Point

Angelica atropurpurea *L.*
Arenaria peploides *L.*
Aristida gracilis *Ell.*
Atriplex pat. littoralis (*L.*)
Cerastium viscosum *L.*
Cirsium spinosissimum (*Walt.*)
Cyperus nuttallii *Eddy*
Fimbristylis castanea (*Mx.*) *Vahl*
Fomes rimosus *Berk.*
Hieracium gronovii *Mx.*
H. scabrum *Mx.*
Hypericum canadense *L.*
Hypochaeris radicata *L.*
Ilex vert. tenuifolia (*Torr.*)
Iris prismatica *Pursh*
Leontodon nudicaulis (*L.*) *Banks*
Ligusticum scoticum *L.*
Myosotis virginica (*L.*) *B. S. P.*
Onopordum acanthium *L.*
Panicum spretum *Schultes*
Picris echioides *L.*
Plantago decipiens *Barneoud*
Polygonum littorale *Link*
Rumex pallidus *Bigel.*
Salsola kali *L.*
Silybum marianum (*L.*) *Gaertn.*
Solidago aspera *Ait.*
Strophostyles helvola (*L.*)
Tripsacum dactyloides *L.*

J. Mickleborough, Brooklyn
Myxosporium castaneum *Pk.*

A. J. Miller, Rensselaer
Nuts of Phytelephas macrocarpa *R. & P.*

G. E. Morris, Waltham, Mass.

Amanita morrisii *Pk.*
A. muscaria *L.*
A. russuloides *Pk.*
Boletinus grisellus *Pk.*
Boletus morrisii *Pk.*
B. spectabilis *Pk.*
Calocera cornea *Fr.*
Clitocybe centralis *Pk.*
C. metachroa *Fr.*
Coprinus niveus (*Pers.*) *Fr.*
Cortinarius ferrug.-griseus *Pk.*
Eccilia flavida *Pk.*
Eccilia pyrina *B. & C.*
Entoloma cuspidatum *Pk.*
E. jubatum *Fr.*
E. rhodopolium *Fr.*
E. salmoneum *Pk.*
Geoglossum nigritum *Pers.*
Hydnum graveolens *Delast.*
H. laevigatum *Sw.*
Lactarius bryophilus *Pk.*
Leotia punctipes *Pk.*
Russula serissima *Pk.*
Tricholoma piperatum *Pk.*

W. A. Murrill, New York

Hypholoma boughtoni *Pk.*
Inocybe infida *Pk.*

H. S. Paine, Glens Falls
Pholiota duroides *Pk.*

C. R. Pettis, Lake Clear Junction
Peridermium strobi *Kleb.*

H. G. Pierce, Rochester
Salix alba *L.*

E. Riesel, Herkimer
Cuscuta arvensis *Beyrich*

W. H. Ropes, Salem, Mass.

Lepiota americana *Pk.*
Lepiota cepaes. lutea (*Bolt.*)
Lepiota friesii *Lasch.*

J. C. Smock, Hudson

Bidens beckii *Torr.*
Erythronium albidum *Nutt.*
Hybanthus concolor (*Forst.*)
Schwalbea americana *L.*

P. Spaulding, Washington, D. C.
Peridermium strobi *Kleb.*

E. B. Sterling, Trenton, N. J.

Agaricus eludens *Pk.*
Agaricus magniceps *Pk.*

F. C. Stewart, Geneva

Erysiphe cichoracearum *DC.*
Hypholoma perplexum *Pk.*
Fomes ribis (*Schum.*) *Fr.*
Microcera coccophila *Desm.*
Phomopsis stewartii *Pk.*

H. L. True, McConnelsville, O.

Polyporus flavovirens *B. & R.*
Xylaria digitata (*L.*) *Grev.*

B. D. VanBuren & S. H. Burnham, Albany

Collybia velutipes (*Curt.*) *Fr.*

J. M. VanHook, Greencastle, Ind.

Hydnum laciniatum *Leers*

H. Wardell, Middleburg

Lappula virginiana (*L.*) *Greene*

H. L. Wells, New Haven, Conn.

Agaricus rodmani *Pk.*

F. B. Wheeler, Syracuse

Morchella crispa *Karst.*
Morchella rimosipes *DC.*
Pholiota aurivella *Batsch*

H. H. Whetzel, Ithaca

Ascochyta solani-nigri *Diedicke*

T. E. Wilcox, Washington, D. C.

Amanita flavorubescens *Atk.*

D. B. Young, Albany

Amanitopsis vaginata (*Bull.*) *Roze*
Boletus albus *Pk.*
B. piperatus *Bull.*
Eccilia atrides *Lasch.*
Entoloma salmoneum *Pk.*
Lactarius deliciosus *Fr.*
L. oculatus (*Pk.*) *Burl.*
Russula fragilis (*Pers.*) *Fr.*
Sporotrichum larvatum *Pk.*

SPECIES NOT BEFORE REPORTED

Ascochyta solani-nigri Diedicke

Living leaves of egg plant, Solanum melongena L. Ithaca. October. H. H. Whetzel.

Agropyrum tenerum Vasey

Brownsville, Jefferson co. and Adirondack mountains. June and July. Formerly confused with Agropyrum violaceum Lange.

Belonidium glyceriae n. sp.

Receptacle 1–1.5 mm broad, gregarious, sessile, plane or convex, glabrous or merely papillate on the under side, pale yellow; asci subclavate or subfusiform, obtuse, 120–130 x 14–18 μ; spores oblong or subcylindric, straight or slightly curved, 3-septate, often 4-nucleate, crowded or biseriate, 35–40 x 4–5 μ, paraphyses filiform.

Dead culms of Glyceria nervata (Willd.) Trin. Lyndonville, Orleans co. June. C. E. Fairman.

Receptaculum 1–1.5 mm latum, gregarium, sessile, planum convexumve, extus glabrum seu papillatum, flavidum; asci subclavati vel subfusiformes, obtusi, 120–130 x 14–18 μ; sporae oblongae vel subcylindraceae, rectae vel leviter curvae, 3-septatae, saepe 4-nucleatae, confertae vel distichae, 35–40 x 4–5 μ, paraphyses filiformes.

Biatora cupreo-rosella (Nyl.) Tuckm.

Limestone rocks. Pine Island, Orange co. November. C. F. Austin.

Bidens tenuisecta Gray

Field near Rochester. August. Miss F. Beckwith. Probably a recent introduction from the West.

Boletus viridarius Frost

Grassy places near pine trees. Poughkeepsie. September and October. Miss H. L. Palliser. For description of this species see article on " Edible fungi " in another part of this report.

Bromus altissimus Pursh

Rathbone, Steuben co. and North Greenbush, Rensselaer co. August to October. Formerly confused with Bromus ciliatus L.

Cardamine douglasii (Torr.) Britton

Niagara Falls and Syracuse. May. Formerly referred to Cardamine rhomboidea purpurea Torr., but now recognized as a distinct species.

Carduus crispus L.

Fields. Helderberg mountains. October. S. H. Burnham. A recently introduced plant, very spiny but beautiful.

Carex bebbii Olney

Common. Formerly considered a variety of Carex tribuloides Wahl., but now recognized as a distinct species.

Carex crawfordii Fern.

Common. Previously known as Carex scoparia minor Boott, but raised to specific rank in the New Manual.

Chaenactis stevioides H. & A.

Newly seeded lawn. Rochester. Miss F. Beckwith. Probably a recent introduction from the West.

Ciboria luteo-virescens R. & D.

On petioles of fallen maple leaves. Lyndonville. C. E. Fairman.

Clitocybe candida Bres.

Woods. West Fort Ann, Washington co. October. S. H. Burnham. The pileus in these specimens is not a pure white as might be inferred from the specific name, but is tinged in the center with yellowish or grayish brown hues. It is also sometimes eccentric.

Cortinarius subsalmoneus Kauffm. Ms.

Woods. Hague, Warren co. September. S. H. Burnham. The full description of this species has not yet been published, but the specimens agree with those characters published in the *Key to the Species of Cortinarius* and in the author's manuscript description.

Crataegus brevipes n. sp.

Leaves ovate or broadly ovate, acute, rounded or broadly cuneate at the base, with 2–3 very slight broad lobes each side or scarcely lobed, with marginal teeth short, broad and blunt, glabrous except

a few hairs on the upper surface of the midrib near the base, slightly bronze tinged when unfolding, soon green or yellowish green, paler beneath, becoming darker green and firm, those on vigorous shoots larger, subcoriaceous, more distinctly lobed, and broadly rounded or subtruncate at the base, petioles short, 6–12 mm long, slightly margined at the top, nearly or quite glandless.

Flowers 5–10 in a cluster, 1.6–2.4 mm broad, commonly on simple glabrous pedicels 6–12 mm long, calyx lobes irregular, often abruptly narrowed toward the reddish apex, entire or with few marginal glands, slightly hairy inside; stamens 8–10, anthers pink; styles 3–4.

Fruit erect, globose or depressed globose, 1–1.4 cm long, 1.2–1.4 cm broad, angular, scarcely or not at all pruinose, 3–8 in a cluster, supported on short glabrous pedicels, dull red or blotched with green, nutlets 3–4, 7–8 mm long.

A shrub 2–3 m tall, with wide spreading branches armed with stout, nearly straight spines 2.5–4 cm long. Flowers the last week in May. Fruit ripe the latter part of September.

Rocky hilly places. Corning, Steuben co. The species evidently belongs to the Pruinosae group, though the fruit is not distinctly pruinose. The specific name has reference to the short pedicels, by which character the species is distinguished from all others of this group known to me.

Folia ovata vel late ovata, acuta, basi rotundata vel late cuneata, utrique 2–3 lobata, seu vix lobata, dentibus brevibus, latis, obtusis, margine serrata, glabra, nisi pilis paucis in venis ad basem, juventate leviter rufobrunnea, mox viridia, infra pallidora, in maturitate virescentiora et subcoriacea, petiolae 6–12 mm longae, ad apicem leviter marginatae fere eglandulosae.

Flores 5–10 in corymbo, 1.6–2.4 cm latae, in pedicellis glabris, vulgo simplicibus, 6–12 mm longis, calicis lobi irregulares, saepe ad apicem abrupte angustati et rubri, integri vel glandis paucis, intra leviter hirti, stamines 8–10, antherae rosaceae; styles 3–4.

Poma 1–1.4 cm longa, 1.2–1.4 lata, angularia, epruinosa, brevibus glabris erectis pedicellis suffulta, sanguinea, nuculae 3–4, 7–8 mm longae.

Diplocladium penicilloides Sacc.

Decaying specimens of Polyporus resinosus (Schrad.) Fr. Helderberg mountains. May. S. H. Burnham.

Diplodia cercidis E. & E.

Dead branches of cultivated Cercis japonica Sieb. Lyndonville. July. C. E. Fairman.

Diplodia hamamelidis n. sp. Fairm. in litt.

Perithecia gregarious, minute, depressed globose, black, at first covered by the epidermis, then erumpent; spores at first colorless, then colored, for a long time continuous, finally uniseptate, 20–28 x 10–12 μ.

Dead branches of witch hazel, Hamamelis virginiana L. Lyndonville. September. C. E. Fairman.

Perithecia gregaria, minuta, depresso-globosa, nigra, primus epidermide tecta, deinde erumpentia; sporae primus hyalinae, deinde coloratae, diu continuae, denique uniseptatae, 20–28 x 10–12 μ.

Diplodia tamariscina Sacc.

Dead branches of cultivated Tamarix parviflora DC. Lyndonville. July. C. E. Fairman.

Discina leucoxantha Bres.

Ground, under beech trees. Altamont, Albany co. May.

Dothiorella divergens n. sp.

Clusters of perithecia 1–3 mm broad, seated on or immersed in a black stroma, suborbicular or elliptic, erumpent, surrounded by the ruptured epidermis; perithecia irregular, unequal, submembranous, black, pallid within; spores oblong, obtuse, straight or slightly curved, sometimes uninucleate, hyaline rarely becoming greenish or yellowish, 20–30 x 9–10 μ.

Dead branches of apple tree, Pyrus malus L. Menands, Albany co. May.

This species differs from Dothiorella mali E. & E. and D. pyrenophora Karst. & Sacc. in its much larger spores. It diverges from the generic character in sometimes having spores slightly tinged with green or yellow.

Caespites peritheciorum 1–3 mm lati, insidentes stromate nigro, suborbiculares seu ellipsoidei, erumpentes, epidermide rupta circumdati; perithecia irregularia, inaequalia, submembranacea, atra, intus pallida; sporae oblongae, obtusae, rectae, vel leviter curvae, aliquando uninucleatae, hyalinae, rare viridescentes seu flavescentes, 20–30 x 8–10 μ.

Epipactis tesselata (Lodd.) Eaton

Woods. Gansevoort, Saratoga co. August.

Fenestella amorpha E. & E.

Dead branches of hickory. Lyndonville. July. C. E. Fairman.

Geum flavum (Port.) Bickn.

Greenburg, Westchester co. E. C. Howe. Shushan, Washington co. September. S. H. Burnham.

Hypholoma boughtoni n. sp.

PLATE II, FIG. 1-7

Pileus fleshy, thin except in the center, broadly convex or subhemispheric, rarely with a slight umbo, glabrous or slightly fibrillose, often concentrically and areolately cracking, pale reddish brown or grayish brown, flesh whitish, taste disagreeable; lamellae unequal, moderately close, adnate, purplish brown, seal brown or blackish, obscurely spotted, whitish on the edge; stem equal, floccosely fibrillose, striate at the top, hollow, white or whitish; spores black on white paper, broadly elliptic, apiculate, 10-12 x 7-8 μ.

Pileus 2.5-7 cm broad; stem 2.5-6 cm long, 4-10 mm thick.

Ground in woods and in open places. Near Pittsford, Monroe co. and at Menands. August. F. S. Boughton and C. H. Peck.

This species is closely allied to Hypholoma velutinum (Pers.) Fr. from which it may be separated by its dry, not hygrophanous, pileus, its whitish flesh and stem, the absence of cystidia and the larger spores. The spore print of both this and Hypholoma rigidipes Pk. is black on white paper. This would indicate a close relationship to the Melanosporae, not only of these two species, but probably also of the closely related species H. velutinum (Pers.) Fr. and H. lacrymabundum Fr.

Pileus carnosulus, centro excepto, late convexus vel subhemisphaericus, rare subumbonatus, glaber vel subglaber, saepe rimosus, rufo-brunneus vel griseo-brunneus, carne albida, sapore ingrato; lamellae inaequales, subconfertae, adnatae, obscure maculatae, purpureo-brunneae, atro-brunneae vel nigrescentes, acie albida; stipes aequalis, floccoso-fibrillosus, ad apicem striatus, cavus, albidus; sporae in fundamento candido atrae, late ellipsoideae, apiculatae, 10-12 x 7-8 μ.

Hypholoma rigidipes n. sp.

PLATE III, FIG. 1–6

Pileus fleshy, thin, convex or broadly convex, dry, fibrillose-squamulose, tawny brown (raw umber), often reddish in the center, flesh whitish, odor slight or none, taste mild; lamellae narrow, close, slightly sinuate, adnexed, brownish red becoming black or purplish black with age; stem slender, rigid, equal, hollow, fibrillose squamulose, colored like the pileus or a little paler; spores subellipsoid, apiculate, 10–12 x 6–8 μ.

Pileus 2.5–5 cm broad; stem 5–10 cm long, 4–6 mm thick.

Gregarious. Damp places under tall herbs. North River, Warren co. September.

This is closely related to Hypholoma lacrymabundum Fr. from which it may be separated by its smaller size, gregarious mode of growth, slender, rigid, equal, darker colored stem, larger spores and slight evanescent veil.

Pileus carnosulus, convexus vel late convexus, siccus, fibrilloso-squamulosus, umbrinus, saepe in centro rubescens, carne albida, sapore mite; lamellae angustae, confertae, adnexae leviter sinuatae, rufo-brunneae, deinde purpureo-atrae vel nigrescentes; stipes gracilis, rigidus, aequalis, cavus, fibrilloso-squamulosus, pileo in colore similis; sporae subellipsoideae, apiculatae, 10–12 x 6–8 μ.

Juncus brachycephalus (Engelm.) Buchen.

Jamesville, Onondaga co. and Sevey, St Lawrence co. July and August. Formerly reported as a variety of Juncus canadensis Gay.

Juncus brevicaudatus (Engelm.) Fern.

West Albany, Sand Lake and Adirondack mountains. August and September. Formerly reported as a variety of Juncus canadensis Gay.

Juncus secundus Beauv.

Blue Mountain Lake, Hamilton co. August. Reported as a variety of Juncus tenuis Willd.

Juniperus horizontalis Moench

Bergen swamp, Genesee co. Formerly reported as a variety of Juniperus sabina L.

Leontodon nudicaulis (L.) Banks

Orient Point, Suffolk co. September. R. Latham.

Leskea gracilescens Hedw.

Trunks of trees. Kingston. July. Mrs M. E. Williams.

Ligusticum scoticum L.

Orient Point. September. R. Latham.

Lophiotrema hysterioides E. & E.

Decorticated twigs and branches lying on the ground in woods. Lyndonville. September. C. E. Fairman.

Lophiotrema littorale Speg.

Dead branches of willow. Lyndonville. May. C. E. Fairman.

Marasmius alienus n. sp.

Pileus thin, tough, convex, subpruinose, dry, pallid or pale buff, with a thin straight margin; lamellae subarcuate, distant, slightly decurrent, creamy yellow, becoming brownish in drying; stem slender, firm, hollow, subpruinose, pallid; spores oblong or narrowly elliptic, 8–10 x 4–5 μ.

Pileus 6–12 mm broad; stem 2.5–5 cm long, .5–1 mm thick.

Mossy prostrate trunks of trees in woods. Fine, St Lawrence co. August.

This species belongs to section 3, subsection 2, of Professor Morgan's *Synopsis of North American Species of Marasmius.*

Pileus tenuis, lentus, convexus, subpruinosus, siccus, pallidus vel subluteolus, margine tenue, recto; lamellae subarcuatae, distantes, leviter decurrentes, cremeae, in siccitate brunnescentes; stipes gracilis, firmus, fistulosus, subpruinosus, pallidus; sporae oblongae vel anguste ellipsoideae, 8–10 x 4–5 μ.

Melanopsamma confertissima (Plowr.) Sacc.

Dead branches of spice bush, Benzoin aestivale (L.) Nees. Lyndonville. C. E. Fairman.

Microcera coccophila Desm.

Parasitic on San José scale infesting living branches of apple trees. Hicksville, Nassau co. October. F. C. Stewart. A welcome enemy to a very unwelcome foe to fruit trees and shrubs.

Midotis irregularis (Schw.) Cke.

On decaying wood. Indian Lake, Hamilton co. October.

Monolepis nuttalliana (R. & S.) Wats.

Rochester. Miss F. Beckwith. September. An interesting member of the Goosefoot family. It has probably been recently introduced from the western part of the country.

Morchella crispa Karst.

Near Syracuse. May. F. B. Wheeler. It resembles Morchella conica Pers. but may be distinguished from it by the more irregular tortuous ribs of the cap, the chinks at the base of the stem and the longer spores.

Morchella rimosipes DC.

Near Syracuse. May. F. B. Wheeler. Probably both this and the preceding species of morel are edible, but as I have had no opportunity of making a personal test of their edible quality they are not here recorded as such.

Naias gracillima (A. Br.) Magn.

Water holes near West Albany. September. Formerly reported as a variety of Naias indica Willd. but now considered a distinct species.

Nardia crenulata (Sm.) Lindb.

Near Calamity pond, Essex co. August. Miss A. Lorenz.

Nardia hyalina (Lyell) Carr.

Banks of Marcy brook, Essex co. July. Miss A. Lorenz.

Panicum implicatum Scribn.

Albany; Machias, Cattaraugus co. and Adirondack mountains. July. Formerly confused with Panicum pubescens Lam. and P. lanuginosum Ell.

Panicum oricola H. & C.

Manor and Riverhead, Suffolk co. and Fulton Chain, Herkimer co. July and August. Formerly confused with Panicum dichotomum L. and P. atlanticum Nash.

Panicum spretum Schultes

Near Albany; Riverhead and Orient Point, Suffolk co. and Whitehall, Washington co. July. Formerly confused with Panicum dichotomum L.

Peridermium strobi Kleb.

Seedling white pines, Pinus strobus L. Lake Clear Junction, Franklin co. October. Perley Spaulding and C. R. Pettis. Our specimens are immature.

This parasitic fungus is destructive to white pine trees. It is dimorphic. Cronartium ribicola Dietr. is a form which develops on leaves of currant bushes. Its spores are capable of infecting white pine trees and reproducing the pine rust, Peridermium strobi, in them. To prevent this it is important that currant and gooseberry bushes whose leaves are attacked by the Cronartium should be destroyed at once.

Pezizella lanceolato-paraphysata Rehm

Dead stems of cultivated Spiraea filipendula L. Lyndonville. June. C. E. Fairman.

Phaeopezia fuscocarpa (E. & H.) Sacc.

Decaying wood. Kasoag, Oswego co. July.

Pholiota aurivella Batsch

Decaying wood of maple. Near Syracuse. October. F. B. Wheeler.

Phomopsis stewartii n. sp.

Perithecia gregarious, commonly occupying grayish or brown spots, thin, subcutaneous, at length erumpent, depressed, minute, 1/3–1/2 mm broad, black; spores of two kinds, first, filiform, curved, flexuous or uncinate, hyaline, 16–25 x 1–1.5 μ, second, oblong or subfusiform, hyaline, commonly binucleate, 8–12 x 2–3 μ; sporophores slender, equal to or shorter than the spores.

On stems of Cosmos bipinnatus Cav. Garden of Agricultural Experiment Station, Geneva, Ontario co. October. F. C. Stewart.

Perithecia gregaria, maculas griseas seu brunneas vulgo occupantia, tenua, subcutanea, deinde erumpentia, depressa, minuta, 1/3–1/2 mm lata, nigra; sporae dimorphae, primum, filiformes, cur-

vatae, flexuosae hamataeve, hyalinae, 16–25 x 1–1.5 μ, secundum. oblongae vel subfusiformes, hyalinae, vulgo binucleatae 8–12 x 2–3 μ, sporophores graciles, sporis aequales vel breviores.

Picris echinoides L.

Orient Point. September. R. Latham.

Potamogeton richardsoni (Benn.) Rydb.

Lake Champlain and Oneida lake. August. Formerly reported as a variety of Potamogeton perfoliatus L. but now classed as a distinct species.

Psilocybe nigrella n. sp.

PLATE III, FIG. 7–11

Pileus thin, broadly convex or nearly plane, slightly umbonate, hygrophanous, seal brown and shining when moist, even and obscurely striate on the margin, raw umber or mummy brown when the moisture has escaped; lamellae thin, rather close, rounded behind, adnexed, purple brown or seal brown, whitish on the edge: stem firm, rigid, equal, stuffed with a slender white pith, silky fibrillose, whitish; spores dark purplish brown, almost black, ellipsoid, 10–12 x 6–8 μ.

Pileus 2.5–4 cm broad; stem 3.5–7 cm long, 2–4 mm thick.

Damp mossy ground in swamps. Karner, Albany co. October.

Pileus tenuis, late convexus subplanusve, leviter umbonatus, hygrophanous, atrobrunneus, nitidus, levis, margineque obscure striatus in conditione uda, umbrinus in siccitate; lamellae tenues, subconfertae, adnexae, atrobrunneae, acie albidae; stipes firmus, rigidus, aequalis, medulla alba farctus, sericeo-fibrillosus, albidus; sporae purpureo-brunneae vel subatrae, ellipsoideae, 10–12 x 6–8 μ.

Puccinia epiphylla (L.) Wettst.

Living leaves of low spear grass, Poa annua L. Lyndonville. September. C. E. Fairman.

Ribes triste albinervium (Mx.) Fern.

Colton hill swamp. Fine. August.

This is closely related to Ribes vulgare Lam., the common garden currant, from which it may be separated by its more straggling, partly decumbent habit and by the glands on the pedicels.

The variety differs from the typical form in having the leaves glabrous on the lower surface.

Rubia tinctorum L.

Near Smiths Basin, Washington co. October. S. H. Burnham. Introduced and formerly cultivated for its roots, which yield a coloring matter suitable for dyeing. It has persisted several years in the locality cited.

Rumex pallidus Bigel.

Orient Point. July. R. Latham.

Rubus andrewsianus Blanch.

Sandy soil. Islip, Suffolk co. Formerly considered a small form of Rubus villosus frondosus Bigel.

Rubus permixtus Blanch.

Light soil in pastures. North Elba, Essex co. July. Formerly referred to Rubus procumbens Muhl.

Rubus recurvans Blanch.

Pine Plains, Dutchess co. and Snyders Corners, Rensselaer co. July and August. Formerly considered a variety of Rubus villosus Ait. of the older botanies.

Septoria sedicola n. sp.

Spots orbicular, 4–8 mm broad, usually one or two on a leaf, at first definite, depressed and without discoloration of the surrounding leaf tissue, at length convex above, concave beneath, the surrounding part of the leaf becoming yellowish, thin and flaccid, finally the whole leaf dying; perithecia numerous, minute, amphigenous, black; spores filiform, straight, curved or flexuous, enucleate, 20–40 μ long, 1–1.5 μ thick.

Living leaves of live-for-ever, Sedum purpureum Tausch. (Sedum telephium L. Man. ed. 6.) Fine. August.

This fungus is closely allied to Septoria sedi West. from which I have separated it because of its amphigenous perithecia and its enucleate spores. The host plant is very tenacious of life and on that account a very undesirable weed though it spreads slowly. This parasite is injurious to it and tends to keep it in check and may therefore be considered a beneficial fungus.

Maculae orbiculares, 4–8 mm latae, vulgo in ullo folio una duove, primus definitae, depressae, in partibus folii circumdantibus, absque decoloratione, deinde convexae supra, concavae infra, foliis flavescentibus, tenuibus, flaccidis, moribundis; perithecia numerosa, minuta, amphigena, nigra; sporae filiformes, rectae, curvatae flexuosaeve, enucleatae, 20–40 x 1–1.5 μ.

Solidago aspera Ait.

Orient Point. September. R. Latham.

Sparganium americanum Nutt.

Lakes and ponds. Sand Lake, Rensselaer co. July. Formerly regarded as Sparganium simplex nuttallii Engelm.

Sparganium angustifolium Mx.

Lake Placid, Essex co. Formerly recorded as Sparganium simplex angustifolium (Mx.) Engelm.

Sparganium diversifolium Graebn.

Shushan. September. S. H. Burnham.

Stachys sieboldii Miq.

Along the railroad near Whitehall. September. S. H. Burnham.

This is sometimes designated as Stachys tuberifera Naud., a name suggested by its tuberous edible roots. It bears the common names knot root, Chinese artichoke and Japan artichoke.

Stephanoma strigosum Wallr.

In woods. Lyndonville. August. C. E. Fairman.

This fungus is parasitic on Lachnea hemisphaerica Wigg. In the generic and specific descriptions some of the characters of the host plant are confusingly incorporated as if they belonged to the parasite.

Sterigmatocystis ochracea (Wilh.) VanTigh.

On diseased gladiolus bulbs and other vegetable matter kept under a bell glass in the office of the State Entomologist. Albany. April and May. J. B. Bartlett.

Trametes merisma n. sp.

Pileus coriaceous, fibrous, tough, commonly deeply divided into several pileoli, uneven, tuberculose, colliculose or diminutively proliferous, subpubescent, white or whitish, flesh pure white, the margin obtuse, sterile beneath; pores minute, 2–3 in a millimeter, developing from the center toward the margin, white, the edge of the dissepiments at first obtuse; stem like base short or none; spores not seen.

Pileus 2.5–7 cm broad.

Decaying prostrate trunks of beech trees, F a g u s g r a n d i f o l i a Ehrh. Fine. August.

This singular fungus sometimes develops from the lower surface of the trunk, in which case a tubercle first appears and the pendent pileus develops from it and is centrally attached to it by the apex. The context of the pileus is similar to that of species of Polystictus, but the character of the pores indicates a closer connection with **Trametes.**

Pileus coriaceous, fibrosus, lentus, vulgo in pileolos paucos profunde divisus, asper tuberculosus colliculosus vel leviter proliferus, subpubescens, albus albidusve, carne candida, margine obtuso, infra sterile; pori minuti, .3–.5 mm lati, a centro ad marginem patescentes, albi, dissepimentis obtusis, stipes brevis vel nullus.

Trichosporium variabile n. sp.

Widely effused, forming thin indefinite blackish patches; hyphae prostrate or suberect, simple or branched, continuous or rarely septate, 4–5 μ in diameter, brown by transmitted light or partly hyaline; spores varying from globose to oblong, colored, 6–10 μ in diameter or 8–12 x 6–8 μ.

On building paper kept in rolls under shelter. Lyndonville. September and November. C. E. Fairman.

The species is remarkable for the variability in the size and shape of the spores. They are intermingled, but the oblong spores are more numerous than the globose. It differs from T r i c h o s p o r i u m c h a r t a c e u m (Pers.) Sacc. in its much larger spores.

Late effusum, stratum tenue indeterminatum nigrescens formans; hyphae repentes suberectaeve, simplices ramosaeve, continuae vel leviter septatae, 4–5 μ crassae, fuscae seu partim hyalinae; sporae fuscae, globosae, 6–10 μ latae, vel oblongae, 8–12 x 6–8 μ.

Verticillium rexianum Sacc.

Parasitic on Arcyria cinerea (Bull.) Pers. Fine. August.

Volvaria volvacea (Bull.) Fr.

Pittsford. August. F. S. Boughton. This is a white form with the silky fibrils of the pileus paler than in the typical form.

Zizania palustris L.

Shores of Lake Champlain near Whitehall and Dresden. August and September. This grass was formerly confused with Zizania aquatica L. but is now separated as a distinct species, distinguished by its broader leaves.

REMARKS AND OBSERVATIONS

Cardamine bulbosa (Schreb.) B. S. P.

This name takes the place in the New Manual of Cardamine rhomboidea DC. in Gray's Manual, ed. 6. Fine flowering specimens of it were collected in May near Little's pond, Albany co.

Centaurea solstitialis L.

This recently introduced plant is apparently spreading, specimens having been received the past season from Highland, Ulster co., where it was collected by C. J. Elting, and from the southern part of Cayuga co., collected by A. D. Baker.

Cerastium viscosum L.

Orient Point. May. R. Latham. This is a rare species in our State.

Crataegus verecunda gonocarpa n. var.

Leaves thin, elliptic, oval or suborbicular, obtuse or acutish, rounded at the base, yellowish green, green with age, becoming glabrous except a few scattered hairs on the upper surface, not at all or only slightly broadly lobed above the middle, the margins often curved upward, petioles 4–10 mm long, slightly margined above, glabrous or with few hairs in the furrow, with few or no glands.

Flowers 5–10 in a cluster, 12–14 mm broad, on short mostly simple pedicels less than an inch long, calyx lobes linear, glabrous, subentire; stamens 1–7, anthers whitish; styles 2–3.

Fruit erect or nearly so, compressed or obtusely 3-angled, dark red when ripe, with numerous minute yellowish lenticels, 10–12 mm long, 7–12 mm broad, compressed fruits about 7 mm in the narrow diameter, 12 mm in the broad diameter, flesh greenish yellow, hard and dry, nutlets 2–3, 7–9 mm long.

Rocky hillside. Corning. May 29, September 17 and 21.

A shrub 2–3 m tall with numerous spreading branches armed with curved spines 2.5–4 cm long, commonly pointing toward the base. The leaves on vigorous shoots are larger than the others, nearly orbicular and more distinctly lobed. The characters which specially distinguish this from the typical plant are its more entire elliptic or suborbicular leaves, its shorter pedicels and its compressed or bluntly angular fruit.

A planta typica differt in foliis magis integris, ellipticis vel sub-orbicularibus, pedicellis brevioribus et fructibus compressis vel obtuse triquetris.

Epilobium densum Raf.

Waste places. Fine. August. The name here used takes the place of Epilobium lineare Muhl. used in *Gray's Manual*. ed. 6.

Erythronium albidum Nutt.

This plant formerly grew in the vicinity of Albany but it long ago disappeared from this region. A specimen of it has been contributed by Prof. J. C. Smock, which was collected many years ago and has " Albany " on the label. A specimen in Beck herbarium is labeled " Wet meadows, Albany."

Exoascus pruni Fckl.

This parasitic fungus, which causes the enlargement of the fruit known as " bladder plums," was very prevalent about Rossie, St Lawrence co., in June. Many trees of both the wild black plum, Prunus nigra Ait., and the wild red plum, Prunus americana Marsh., had scarcely a sound plum on them.

Galium erectum Huds.

This introduced species of bedstraw is abundant in pastures and along roadsides near Hudson. It spreads by subterranean root-stocks and threatens to be a pernicious weed.

Hedeoma hispida Pursh

Two stations are now known in the State for this rare plant, Little Falls and Shushan.

Ilex verticillata tenuifolia (Fern.) Wats.

Orient Point. July. R. Latham.

Lactuca scariola integrata G. & G.

In the *New Manual* this name designates the wild lettuce previously referred to Lactuca virosa. This lettuce has now become very common in and around many cities and villages in the State.

Laportea canadensis L.

There are two forms of this nettle. One is common in moist or wet places. It has a slender stem, thin leaves on long slender petioles and usually bears a terminal cluster of pistillate flowers only.

The other is rare, grows in dry soil or upland either in woods or open places, has a stouter stem, thicker leaves on shorter petioles and frequently bears staminate flowers in the axils of most of the leaves, either with or without a terminal cluster of pistillate flowers. This form was found by the roadside at Fine and in woods near Castorland, Lewis co.

Listera australis Lindl.

A single plant was found in a large swamp near Fine. August.

Marasmius oreades Fr.

A variety with the pileus white or whitish occurs in grassy ground at Rossie. September.

Omphalia rugosodisca levidisca n. var.

Decaying wood. Fine. August. This differs from the typical form only in having the center of the pileus even.

Pileus in centro levis.

Peridermium consimile A. & K.

Leaves of black spruce, Picea mariana (Mill.) B. S. P. Fine. August.

Polyporus giganteus (Pers.) Fr.

About old stumps in woods. Fine. August. This species forms large clusters of pilei which are at first whitish or pale grayish brown, but they become brown or blackish brown in age or in drying. The minute white pores when fresh assume a blackish color where bruised and sometimes become black in drying.

Prunus pumila L.

Pulaski, Oswego co. August. C. E. Jones. The plants growing in sandy soil northwest of Albany and formerly referred to Prunus pumila are now referred to Prunus cuneata

Raf., which species is characterized by its more erect mode of growth.

Pyrus coronaria L.

The leaves of the American crabapple are quite variable. In one form they are gradually narrowed toward the acute apex but broad at or near the base and often somewhat lobed; in the other they are more or less oblong or elliptic and barely acute at the apex.

Pyrus melanocarpa (Mx.) Willd.

Fruiting specimens of this species were collected at the same time from shrubs on opposite sides of a path in a swamp near Fine. The shrub on one side of the path had black fruit, on the other, dark red.

Solanum nigrum L.

Although the fruit of this plant is reputed poisonous, nevertheless in some places it is used in making pies. The plant is even cultivated for its fruit. A form bearing very large fine fruit was observed in a garden at Rossie and the proprietor assured me that he used the fruit for food. Cooking appears to destroy its deleterious qualities. The cultivated form is locally known as "garden huckleberry."

Solidago squarrosa ramosa n. var.

Corning. September. This differs from the ordinary form in developing a pyramidal panicle of flowers at the top of the stem. The branches are 2.5–10 cm long, gradually diminishing in length from the base to the top of the panicle. The ray flowers are 8–11, disk flowers 9–14. Leaves more narrow than in the common form.

Panicula pyramidata, ramis 2.5–10 cm longis, flores marginis 8–11, flores disci 9–14, folia angustiora.

Schwalbea americana L.

In the *New Manual* this plant is said to grow in wet sandy soil near the coast. In Beck's *Botany* it is credited to sandy plains near Albany. In Paine's *Catalogue of Oneida County Plants* it is reported as occurring near Center (Karner) station between Albany and Schenectady. A specimen has been contributed to the herbarium by Professor Smock that was credited to Albany and probably collected in or near the locality observed by the author

of Paine's *Catalogue*. In the Beck herbarium there are specimens credited to Albany.

Thalictrum confine Fern.

Rossie. June. Specimens collected near Port Henry and referred to Thalictrum purpurascens L. belong here.

Thalictrum revolutum DC.

This name is used in the *New Manual* to designate the plant formerly referred to Thalictrum purpurascens ceriferum Aust. and the glandular leaved form of Thalictrum purpurascens L.

Viola sororia Willd.

A white or whitish flowered form of this species was found near Rochester in May by Miss F. Beckwith and specimens were contributed by her to the herbarium.

EDIBLE FUNGI

Clitocybe multiceps Pk.

MANY CAP CLITOCYBE

PLATE 117, FIG. 7–9

Pileus fleshy, firm, convex, slightly moist in wet weather, whitish, grayish or yellowish gray, flesh white, taste mild; lamellae close, adnate or slightly decurrent, whitish; stems densely cespitose, equal or slightly thickened at the base, solid or stuffed, firm, slightly pruinose at the top, whitish; spores globose, .0002–.0003 of an inch in diameter (5–8 μ).

The many cap clitocybe is quite constantly tufted in its mode of growth. The tufts may be composed of two or three or many individuals. When there are many individuals in a tuft the caps are generally irregular because closely crowded against each other in their growth. The surface is smooth but sometimes slightly silky and brownish in the center. The color is whitish, grayish or yellowish gray, but the flesh is pure white. The gills are white, closely placed, with intervening short ones, the longest ones reaching the stem and broadly connecting with it or slightly decurrent on it. The stems are stout, nearly equal in diameter in every part,

smooth, solid, white or whitish. They are crowded or even attached to each other at the base.

They may appear at any time from June to October if the weather is sufficiently rainy. The taste, though not acrid, is sometimes slightly disagreeable in the raw state, and unless thoroughly cooked the disagreeable flavor may not be wholly dispelled in preparing the caps for the table. This has given rise to different opinions concerning its edibility. One correspondent declares that he considers it one of the best mushrooms. Another thinks it unfit to eat. My first trials of it were not satisfactory. More recent ones lead me to place it among our edible species though it is scarcely to be considered first-class.

Lactarius aquifluus Pk.

WATERY MILK LACTARIUS

PLATE 118, FIG. 1-6

Pileus fleshy, fragile, convex or nearly plane, at length centrally depressed, sometimes with a small umbo, glabrous or slightly and minutely tomentose, burnt sienna red when young and moist, paler grayish buff or subochraceous when dry, flesh colored nearly like the pileus, milk watery, taste mild or tardily acrid; lamellae thin, close, adnate or slightly decurrent, yellowish; stem equal or slightly tapering upward, glabrous or subpruinose, hollow, paler than the pileus; spores subglobose, .0003-.00035 of an inch in diameter (8-9 μ).

The watery milk lactarius grows in mossy swamps or wet places. rarely as a short stem variety, Lactarius aquifluus brevissimus Pk., in black muck soil in old roads in woods. The plants are generally gregarious but sometimes tufted. The cap is 2-4 inches broad, the stem 1-4 inches long and 4-8 lines thick. It is moist or subhygrophanous in wet weather and even in dry weather when growing in wet places.

The color of the cap is at first yellowish red, but this soon changes to a grayish or pale ochraceous color as the moisture escapes. The flesh is colored similar to the pileus. The milk is scant and watery in appearance. The taste is mild or slowly and slightly acrid. The odor in the fresh plant is weak but agreeable. It becomes stronger in the dried plant and persists a long time. It is not always entirely destroyed even in cooking. It resembles the odor of melilot and is similar to that of Lactarius glyciosmus Fr. and Lactarius camphoratus (Bull.) Fr. The

gills have a pale creamy yellow color and become pruinosely dusted by the spores in the dried plant. They are at first broadly attached to the stem but in specimens having the pileus centrally depressed they become slightly decurrent. The stem is nearly or quite smooth, hollow and colored like, but a little paler than the cap. It is generally about equal to the diameter of the cap in length. In the upland form it is shorter.

The species is closely related to Lactarius helvus Fr. of Europe, which is said by Fries to occur in a degenerate form in swamps and to have a rimose cap and watery milk. If we admit that Fries was correct in considering his watery milk lactarius a degenerate form of his typical Lactarius helvus with white milk, it still remains doubtful if our plant is the same as his, as some have claimed. The reasons for considering it a distinct species are two. First, it is not always an inhabitant of swamps, and, second, I have never found it with the cap rimose. It may be added as a presumptive distinguishing feature that Fries makes no mention of the very noticeable and long persistent odor emitted by the drying and dried plants. The further fact that our plant has never yet been found with white milk, even in its upland growth, leads to the conclusion that it is certainly not a degenerate form but a species constant in its milk character, and in its decided and persistent odor and therefore worthy of specific distinction.

Entoloma grande Pk.

GRAND ENTOLOMA

PLATE 119, FIG. 1–5

Pileus fleshy, thin toward the margin, glabrous, convex becoming nearly plane, often broadly umbonate, sometimes rugosely wrinkled about the umbo, moist in wet weather, yellowish white or grayish brown, flesh white, odor and taste at first farinaceous, then sometimes leaving a disagreeable sensation in the mouth; lamellae broad, subdistant, slightly adnexed, whitish becoming pink; stem equal or nearly so, solid, slightly fibrous externally, mealy at the top, white; spores angular, .0003–.0004 of an inch in diameter (8–10 μ).

The grand entoloma is a large but rare mushroom. It has been found in a single locality near Albany twice in 13 years. It has been found once in the state of Vermont by Professor Burt. It is one of the few species of the genus Entoloma that have a farinaceous taste and odor. It grows in woods and occurs in August. It is

found single or in tufts. The cap is 2–6 inches broad, the stem 1.5–6 inches long and 3–12 lines thick. The cap is convex or somewhat bell shape, becoming nearly flat, whitish to grayish brown in color, its surface is smooth, and in large specimens it is sometimes umbonate and rugosely wrinkled about the umbo. Its flesh is white. The gills are at first whitish or grayish but as they mature they assume the pink color of the spores. They are rounded next the stem and but slightly attached to it. The stem is white or whitish, solid and often mealy at the top.

On account of the disagreeable sensation left in the mouth by tasting the uncooked cap it was thought that this mushroom would probably be found to be unwholesome. But actual experiment has shown that this character is destroyed by thorough cooking and that the mushroom is edible though less highly flavored than some others. Its scarcity makes it of but little importance.

Hebeloma album Pk.

WHITE HEBELOMA

PLATE 117, FIG. 1–6

Pileus fleshy, thin, firm, convex becoming nearly plane or concave by the upcurving of the margin, glabrous, slightly viscid, white or yellowish white, flesh white, taste mild; lamellae thin, narrow, close, adnexed, whitish when young, becoming brownish ferruginous; stem equal, firm, solid, glabrous, slightly mealy at the top, white; spores subelliptic, .0005–.0006 of an inch long, .00025–.0003 broad (12–16 x 6–8 μ).

The white hebeloma is not a common mushroom but it is an excellent one for the table. It is gregarious in its mode of growth and occurs among fallen leaves and mosses or on naked damp soil in woods, and may be found in September and October. The cap is 1–2 inches broad, the stem 1–3 inches long and 2–3 lines thick. Generally the whole plant is white when young but the gills assume a brownish cinnamon or brownish rust color when mature. The edge of the gills is slightly excavated near the stem, to which they are narrowly attached. The cap is sometimes tinged with yellow and the stem is adorned at the top with white particles or a floccose mealiness. In State Museum Report 54, plate G, figures 1–7, the gills and spores are incorrectly colored. A new figure has therefore been prepared.

Boletus viridarius Frost

GREEN LAWN BOLETUS

PLATE 120, FIG. 1–10

Pileus fleshy, convex, viscid when moist, glabrous, dingy whitish, pale ochraceous reddish yellow or pale orange, inclining to reddish brown, flesh whitish or yellowish, unchangeable; tubes from plane to convex, usually slightly depressed around the stem, their mouths small or medium size, subrotund, the dissepiments at first whitish, becoming yellowish or yellowish brown when mature; stem equal or slightly tapering upward, solid, white or yellowish and distinctly reticulated above the slight white annulus, pallid, reddish or brownish below, whitish or yellowish within; spores oblong-fusiform, .0003–.0005 of an inch long, .00016–.00024 broad (8–12 x 4–6 μ).

Pileus 1–5 inches broad; stem 1–2.5 inches long, 3–6 lines thick.

Grassy ground near pine trees. September and October. Poughkeepsie. Miss H. L. Palliser.

This species is related to Boletus flavus With. by the stem being reticulate above the annulus, but it is far more variable in the color of the pileus and stem, and it also differs in the character of the margin of the pileus, which is often incurved and appendiculate by the remains of the white veil. In none of the specimens seen do I find any green hues, nor is anything said of green or greenish colors in the original description of the species by Mr Frost. We can therefore only infer that the specific name was suggested by the green grassy places in which this Boletus grows.

Its edible qualities have been tested both by Miss Palliser and myself and are considered excellent. The pileus is generally soiled by fragments of dirt or other matter, by reason of which it is better to remove the separable viscid cuticle before cooking. The plants vary in size. Those appearing in September are larger than those appearing in October. The tubes when young are whitish or pale yellow and where wounded assume a pale brownish or fawn color; when older they become brownish yellow and wounds assume a darker brown hue. The veil is white and in the later specimens appears to be more fully developed and more persistent than in the earlier ones. Its fragments in the later ones often adhere to the margin of the cap.

NEW SPECIES OF EXTRALIMITAL FUNGI

Amanita morrisii

PLATE W, FIG. 1–4

Pileus fleshy, subcampanulate becoming broadly convex, viscid when moist, glabrous, even on the margin, with a separable pellicle, dark grayish brown or blackish brown, becoming a little paler with age and with the escape of moisture, flesh white; lamellae thin, close, narrow, rounded behind, slightly adnexed, white; stem equal or slightly tapering upward, slightly bulbous at the base, solid or stuffed, slightly floccose, sometimes grayish and striate at the top, usually white, annulus double, radiately striate above, whitish buff beneath, the slight volva soon breaking into fragments and disappearing or occasionally partly adhering to the lower part of the stem; spores subglobose or broadly ellipsoid, 8–10 x 6–8 μ.

Pileus 5–10 cm broad; stem 8–14 cm long, 12–20 mm thick.

In black vegetable mold among mosses. Natick swamp, Mass. September. G. E. Morris.

Pileus carnosus, subcampanulatus, deinde late convexus, viscidus, glaber, margine leve, pellicula separabile, griseo-brunneus seu atro-brunneus, in senectute vel quum siccus pallidior, carne alba; lamellae tenues, confertae, angustae, leviter adnexae, albae; stipes aequalis, vel sursum attenuatus, solidus farctusve, minute flocculosus, aliquando griseus et ad apicem striatus, vulgo albus, annulus crassus, mollis, supra radiate striatus et alba, infra luteolus, volva in fragmenta mox frangens et vanescens, seu stipitis parti inferori in fragmentis rare adhaerens; sporae subglobosae vel ellipsoideae, 8–10 x 6–8 μ.

Agaricus eludens

PLATE X, FIG. 6–13

Pileus thin, ovate, broadly conic or subcampanulate, sometimes becoming broadly expanded, brown when young, becoming whitish and covered with brown fibrillose squamules, the center smooth, brown, the young margin surpassing the lamellae, flesh white changing to reddish where wounded; lamellae thin, close, narrow, free, whitish becoming bright pink, then chocolate brown and finally black or blackish brown; stem firm, nearly equal or sometimes thickened at the base, often slightly bulbous, fibrous, silky, white, stuffed with a hollow tube, internally white, changing to blood red

where wounded, then to brown or black, annulus thick, persistent, white; spores subglobose or ellipsoid, 5–7 x 4–5 μ.

Pileus 2.5–10 cm broad; stem 2.5–7 cm long, 4–8 mm thick.

Cespitose or single, often in clusters of many individuals. On dumping ground near Trenton, N. J. September. E. B. Sterling.

The pileus closely resembles that of Agaricus placomyces Pk., but the mushroom differs in its commonly tufted mode of growth, the darker color of its mature pileus, the thicker and more persistent annulus, the distinct hollow tube of the stem and specially in the change of color of the wounded flesh and stem. It is also closely allied to Agaricus approximans Pk. from which it may be separated by its lamellae becoming pink before they assume the brown color of maturity. The discoverer pronounces it edible but says its flavor is less agreeable than that of Agaricus campester L.

Pileus tenuis, ovatus, late conicus seu subcampanulatus, aliquando late expansus, quum juvenis brunneus deinde albidus, squamulis brunneis fibrillosis tectus, centro glaber, brunneus, margine juvene lamellas excedente, carne alba, ubi vulnerata rufescente; lamellae tenues, confertae, angustae, liberae, albidae, mox incarnatae, deinde nigro-brunneae; stipes firmus, subaequalis, aliquando basi incrassatus saepe leviter bulbosus, fibrosus, sericeus, albus, tuba cava farctus, carne alba, ubi vulnerata sanguinea, deinde brunnea vel nigra, annulus crassus, persistens, albus; sporae subglobosae vel ellipsoideae, 5–7 x 4–5 μ.

Russula blackfordae

PLATE Z, FIG. 9–13

Pileus fleshy but thin, broadly convex or nearly plane, viscid when moist, striate on the margin, whitish or pale gray, brown in the center, flesh white, taste mild; lamellae thin, narrow, close, adnate, pale yellow or cream color; stem equal, glabrous, stuffed or hollow, white; spores pale yellow, globose, 8–9 μ broad.

Pileus about 2.5 cm broad; stem about 2.5 cm long, 4–6 mm thick.

Ellis, Mass. October. Mrs E. B. Blackford.

This species differs from Russula fallax (Schaeff.) Sacc. in the color of the pileus, the closer and yellowish lamellae, the mild taste and the color of the spores. The viscid pellicle of the pileus is separable. The species belongs to the section Fragiles, second subsection.

Pileus carnosulus, late convexus subplanusve, quum humidus, viscidus, margine striatus, albidus, pallido-griseusve, centro brunneus, carne alba, sapore miti; lamellae tenues, angustae, confertae, adnatae, flavidae vel cremeae; stipes aequalis, glaber, farctus vel cavus, albus; sporae globosae, flavae, 8–9 μ latae.

Russula serissima

Pileus fleshy, thin, fragile, convex becoming nearly plane or centrally depressed, viscid when moist, glabrous, with the margin even or sometimes obscurely striate when old, variable in color, pale olive-green or brownish purple, sometimes spotted in the center, occasionally pruinose, flesh white or whitish, taste mild or slightly and tardily acrid, odor in the dried or drying plant strong, unpleasant, persistent; lamellae thin, close, 4–8 mm broad, narrowed behind, adnexed sometimes seceding from the stem, cream color or buff, becoming dingy or smoky in drying; stem equal or tapering upward, solid but spongy within, white, both it and the flesh assuming a somewhat smoky hue in drying; spores subglobose, buff yellow, 10–12 x 8–10 μ.

Pileus 5–7 cm broad; stem 4–7 cm long, 8-20 mm thick.

Under fallen leaves in woods. Ellis, Mass. October. Mrs E. B. Blackford and G. E. Morris.

The pileus varies in color as does the pileus of Russula variata Banning and Russula squalida Pk. It is very close to the latter, from which it scarcely differs except in its viscid pileus, its late occurrence, its lamellae and flesh not changing color where wounded and specially in the color of the spore print.

Pileus carnosus, tenuis, fragilis, convexus, deinde subplanus vel centro depressus, quum humidus viscidus, glaber, margine levis aliquando in senectute leviter striatus, olivaceus vel brunneo-purpureus, aliquando centro maculatus, rare pruinosus, carne alba albidave, sapore miti vel leviter tardeque acri, odore ingrato, persistente; lamellae, tenues, confertae, 4–8 mm latae, adnexae, cremeae vel luteolae, deinde fumidae; stipes aequales vel sursum attenuatus, solidus, intra spongiosus, albus, deinde fumosus; sporae subglobosae, luteo-flavae, 10–12 x 8–10 μ.

Lactarius bryophilus

PLATE X, FIG. 1–5

Pileus thin, broadly convex or nearly plane, with an even margin, sometimes slightly umbonate, very viscid or glutinous, reddish

becoming subochraceous sometimes with one or two narrow orange zones near the margin, flesh white, taste mild, milk watery, scanty; lamellae unequal, close, adnate, whitish becoming ochraceous buff; stem soft, equal, glabrous, stuffed or hollow, colored like or a little paler than the pileus; spores subglobose, 6–8 μ in diameter.

Pileus 1–4 cm broad; stem 1.5–3.5 cm long, 4–8 mm thick.

Among mosses in swamps. Natick, Mass. September and October. G. E. Morris and S. Davis.

A very rare species hitherto known from no other locality, and only sparingly found in this one. It may be easily recognized by its small size, very viscid subochraceous pileus, mild taste and watery, unchangeable milk. In one or two cases very young specimens have appeared to have white milk, but in mature specimens the milk is constantly watery. This is doubtless its normal color.

Pileus tenuis, late convexus subplanusve, margine levis, subumbonatus, viscosus, rufus deinde subochraceus, aliquando juxta marginem zona angusta auratiaca ornatus, carne alba, sapore miti, lacte aquoso, parco; lamellae inaequales, confertae, adnatae, albidae, deinde flavo-ochraceae; stipes mollis, aequalis, glaber, farctus cavusve, colore pileo similis vel pallidior; sporae subglobosae, 6–8 μ latae.

Naucoria sphagnophila

Pileus thin, convex becoming nearly plane, minutely appressed tomentose and sometimes flocculose squamulose, hygrophanous, when young and moist tinged with flesh color, becoming buff white in drying, grayish ochraceous or rusty brown when mature; lamellae thin, narrow, subsinuate, close, unequal, uneven on the edge, yellowish becoming ferruginous; stem equal, flexuous, solid or at length hollow, yellowish with a slight floccose tomentum at the top, white tomentose at the base; spores ellipsoid, 8–9 x 4–5 μ.

Pileus 1.2–2.4 cm broad; stem 2.5–4.5 cm long, 2–3 mm thick.

Gregarious. In sphagnum in a swamp. Stow, Mass. July. S. Davis.

Pileus tenuis, convexus vel subplanus, minute tomentosulus, aliquando floccoso-squamulosus, hygrophanus, in juventate subincarnatus, in maturitate griseo-ochraceus vel ferrugineus; lamellae tenues, angustae, subsinuatae, confertae, inaequales, acie erosae, flavidae, deinde ferruginae; stipes aequalis, flexuosus, solidus, deinde fistulosus, luteolus, ad apicem minute floccoso-tomentosulus, basi albido-tomentosus; sporae ellipsoideae, 8–9 x 4–5 μ.

Cortinarius ferrugineo-griseus

PLATE Y, FIG. 1–4. PLATE Z, FIG. 1–3

Pileus convex or nearly plane, sometimes with the thin margin upcurved and then appearing centrally depressed, hygrophanous, brownish ferruginous when moist, gray or whitish gray when the moisture has escaped, flesh whitish; lamellae 4–6 lines broad, moderately close, adnexed, appearing free in the dried plant, pale cinnamon or clay color when young, brownish cinnamon when mature; stem equal, abruptly bulbous at the base, solid or stuffed, silky fibrillose, sometimes colored like but paler than the pileus, sometimes shining, variable in color, whitish below and violet tinted above or entirely violaceous, violaceous within; spores ellipsoid and commonly uninucleate, 10–12 x 7–8 μ.

Pileus 3.5–10 cm broad; stem 3.5–8.5 cm long, 6–20 mm thick.

Under pine trees near Natick swamp, Mass. October. G. E. Morris.

The growing plant is often covered with pine needles. It belongs to subgenus Hydrocybe and is closely allied to Cortinarius saturninus Fr., from which it may be separated by its pileus fading to grayish white and by its solid stem often abruptly bulbous. It also differs in its habitat and in its larger spores.

Pileus convexus vel subplanus, aliquando centro depressus, margine recurvato, hygrophanus, quum humidus ferrugineo-brunneus, quum siccus albido-griseus griseusve, carne albida; lamellae subconfertae, adnexae, 8–12 mm latae, in juventute cinnamomeae vel argillaceae, in maturitate brunneo-cinnamomeae; stipes aequalis, basi abrupte bulbosus, sericeo-fibrillosus, nitidus, solidus, infra albidus, supra violaceus, vel omnino violaceus, aliquando in colore pileo similis sed pallidior, interne albidus vel violaceus; sporae ellipsoideae, vulgo uninucleatae, 10–12 x 7–8 μ.

Cortinarius acutoides

PLATE Z, FIG. 4–8

Pileus submembranous, conic or subcampanulate, acute or acutely umbonate, hygrophanous, at first pale chestnut color floccose and white margined by the fibrils of the veil, after the escape of the moisture whitish and silky fibrillose; lamellae narrow, ascending, adnexed, subdistant, yellowish cinnamon; stem solid or with a small hollow, white, becoming whitish like the pileus; spores ellipsoid, 8–10 x 6–7 μ.

Pileus 8–16 mm broad; stem 2.5–5 cm long, 2–3 mm thick.

Swamps. Ellis, Mass. October. Mrs E. B. Blackford.

Closely allied to Cortinarius acutus (Pers.) Fr., from which it differs in the darker color of the young moist pileus and whiter color of the mature dry pileus, the white color of the young stem, the adnexed lamellae, and specially by the larger spores and absence of striae from the moist pileus. This may be the plant mentioned in *Sylloge* as a variety of Cortinarius acutus (Pers.) Fr.

Pileus submembranaceus, conicus subcampanulatusve, acutus vel acute umbonatus, hygrophanus, primus pallido-castaneus, velo albo floccosus, margine albido, quum siccus albescens, sericeo-fibrillosus; lamellae angustae, ascendentes, adnexae, subdistantes, flavido-cinnamomeae; stipes solidus seu leviter cavus, albus deinde pileo in colore similis; sporae ellipsoideae, 8–10 x 6–7 μ.

Clavaria lavendula

Tufts 2.5–4 cm high, densely and subdichotomously branched, the branches compressed, thin, lilac pink when moist, pruinose when dry, the ultimate ones often bidentate, axils rounded; spores minute 6–8 x 3–4 μ.

Chestnut grove. Stow, Mass. July. S. Davis.

This species is related to Clavaria amethystina Bull., but it differs in its flattened branches and smaller spores.

Caespites 2.5–4 cm alti, dense et subdichotome ramosissimi, rami tenues, numerosi, compressi, quum humidi lavenduli, sicci, pallidiores pruinosique, ramuli ultimi saepe bidentati; sporae ellipsoideae, 6–8 x 3–4 .

Clavaria pallescens

Clubs simple, loosely cespitose or gregarious, 2.5–4 cm tall, clavate, soft, fragile, obtuse, pale buff fading to whitish, sometimes minutely rugulose, stuffed or hollow, pale yellow within; stem short, glabrous, 2–4 mm long, pale yellow; spores oblong or elliptic, white, 9–12 x 6–8 μ.

Dry gravelly soil near Kalmia angustifolia L. South Acton, Mass. October. S. Davis and G. E. Morris.

This species is allied to Clavaria ligula Fr. from which it differs in its smaller size, in its color becoming whitish or paler with age or in drying, but being lemon-yellow and more persistent

within, in its glabrous lemon-yellow stem and in its broader spores. It is apparently a rare but very distinct species.

Clavae simplices, laxe caespitosae vel gregariae, 2.5–4 cm longae, clavatae, molles, fragiles, obtusae, luteolae, deinde albescentes, aliquando minute rugulosae, farctae cavaeve, intra flavae; stipes 2–4 mm longus, glaber, flavidus; sporae oblongae vel ellipsoideae, albae, 9–12 x 6–8 μ.

NEW YORK SPECIES OF INOCYBE

Inocybe Fr.

Veil universal, subfibrillose, concrete with the cuticle of the pileus, often free on the margin, webby; lamellae subsinuate (rarely adnate or decurrent) changing color, not cinnamon pulverulent; spores even, angular or rough, more or less brownish ferruginous. *Sylloge* 5:762

The species of this genus are generally of small or medium size. They were formerly included by Fries in the genus Hebeloma, from which the universal veil concrete with the commonly dry pileus specially distinguishes them. The prevailing color of the pileus is brown in some of its shades. In no other genus of the Agaricaceae is it more necessary to make use of the microscope in the identification of the species, for the external resemblance in some is so close that microscopic examination of the spores can not safely be omitted. The presence or absence of cystidia is also a character of some importance in the classification and identification of the species. Nearly all the species are terrestrial, some growing in woods, others in pastures and open places. A few occur on the ground and on decaying wood also. They have been distributed in five sections for convenience of study and the better understanding of their relations to each other. One author has instituted a genus depending on the rough spore character but it does not seem to find much favor among mycologists.

A microscopic examination of the spores would be necessary in such a case before even the generic identification could be made. Many of our species are rare or local, having been found but once and in a single locality.

In the following pages the arrangement of the sections as given in *Sylloge* has been followed. The following key to the sections is based on external characters and indicates the prominent characteristic of each section.

KEY TO THE SECTIONS

Pileus and stem both squamose.............................Squarrosae
Pileus and stem not both squamose.....................................1
1 Cuticle of the pileus lacerated or cracked.............................2
1 Cuticle of the pileus continuous.......................................3
2 Pileus squamose or fibrillosely lacerated.....................Lacerae
2 Pileus radiately rimose and fibrillose.......................Rimosae
3 Pileus not viscid..Velutinae
3 Pileus viscid..Viscidae

Squarrosae

Pileus at first squamose or squarrosely squamose; stem squamose, colored like the pileus, both commonly some shade of brown.

This section differs from the others in having the pileus and stem alike in color and both squamose or squamulose.

KEY TO THE SPECIES

Spores even...1
Spores not even...4
1 Pileus dark brown..2
1 Pileus not dark brown..3
2 Pileus 2.5-5 cm broad, scales persistent.................calamistrata
2 Pileus 1.5-2.5 cm broad, scales subdeciduous................mutata
3 Pileus tawny, stem hollow, fibrillose squamulose..............fibrillosa
3 Pileus subochraceous, stem solid, squamulose...................unicolor
4 Pileus 2.5 cm broad..stellatospora
4 Pileus less than 2.5 cm broad..............................lanuginosa

Inocybe calamistrata Fr.

CURVED SCALE INOCYBE

Sylloge 5: 762

Pileus fleshy, thin, campanulate or convex, obtuse, squarrosely squamose, brown or dark brown, flesh whitish, reddish where wounded; lamellae close, adnexed, whitish becoming ferruginous, the edge thick, whitish; stem equal, tough, solid, squarrosely squamose, brown, bluish at the base; spores oblong or ellipsoid, even. 10–15 x 5–6 μ.

Pileus 1–3 cm broad; stem 3–7 cm long, 2–4 mm thick.

Damp places under trees or bushes. Albany, Essex and Warren counties. August and September.

This species is well marked by the recurved scales of the pileus and stem and the bluish tint at the base of the stem. The European plant is described as having a strong odor but this character is scarcely noticeable in the American plant.

Inocybe mutata (Pk.) Mass.

CHANGED INOCYBE

Ag. (Hebeloma) mutatus Pk. N.Y. State Mus. Rep't 24, p.(?)

Pileus thin, broadly conic or convex, obtuse or slightly and broadly umbonate, at first covered with erect or recurved scales which at length disappear except at the center, dark brown; lamellae broad, close, rounded at the stem, deeply sinuate, adnexed, ferruginous brown, crenulate on the edge; stem slender, equal, solid, floccosely scaly, often curved at the base, brown; spores ellipsoid, even, 9–11 x 5–6 .

Pileus 1.5–2.5 cm broad; stem 5–7 cm long, about 2 mm thick.

Damp ground in woods. Ulster co. July.

The species is closely related to Inocybe calamistrata Fr. from which it may be separated by its smaller size, scales disappearing from the margin, absence of bluish tints from the base of the stem and shorter spores. The changed appearance of the pileus caused by the vanishing scales of the margin is suggestive of the specific name.

Inocybe fibrillosa Pk.

FIBRILLOSE INOCYBE

N. Y. State Mus. Rep't 41, p.65

Pileus thin, convex or nearly plane, obtuse or subumbonate, densely fibrillose, tawny, generally a little darker in the center and there adorned with appressed fibrillose scales; lamellae close, adnate, yellowish or yellowish olivaceous becoming brownish cinnamon; stem equal, hollow, fibrillosely squamose, colored like or a little paler than the pileus; spores ellipsoid, even, 8–10 x 5–6 μ.

Pileus 2–3.5 cm broad; stem about 2.5 cm long, 2–4 mm thick.

Damp mossy banks in woods. Albany co. August. A rare species.

Inocybe unicolor Pk.

ONE COLORED INOCYBE

N. Y. State Mus. Rep't, 50, p.104

Pileus conic or very convex becoming broadly convex or nearly plane, tomentosely squamulose, pale ochraceous or grayish ochraceous, flesh white; lamellae broad, subdistant, subventricose, pale ochraceous becoming tawny brown; stem slender, firm, equal, flexu-

ous, solid, squamulose, colored like the pileus; spores ellipsoid, even, 8–12 x 5–6 μ.

Pileus 2–2.5 cm broad; stem 2.5–3 cm long, 2–4 mm thick.

Clay soil. Albany co. July. Rare.

This species approaches Inocybe subochracea (Pk.) Mass. in color, but it differs in having the stem squamulose and colored like the pileus and in its larger spores.

Inocybe stellatospora (Pk.) Mass.

STELLATE SPORE INOCYBE

Ag. (Hebeloma) stellatosporus Pk. N. Y. State Mus. Rep't 26, p.57

Pileus thin, convex or nearly plane, dry, covered with erect or curved scales, dark brown; lamellae close, adnate, pallid becoming brown or slightly rusty brown; stem equal, firm, solid, squamose, colored like the pileus; spores subglobose, nodulose, 7–8 μ in diameter, cystidia 70–80 x 14–20 μ.

Pileus about 2.5 cm broad; stem 4–5 cm long, about 2 mm thick.

In woods. Lewis co. September.

In size and color this species resembles Inocybe mutata (Pk.) Mass. but it is easily distinguished by its persistent scales on the pileus and by its nodulose spores.

Inocybe lanuginosa (Bull.) Karst.

WOOLLY INOCYBE

Ag. (Inocybe) nodulosporus Pk. N. Y. State Mus. Rep't 32, p.28

Pileus thin, hemispheric or convex, obtuse, floccosely squamose, cervine brown or umber color, the scales of the disk usually erect; lamellae close, broad, ventricose, rounded at the stem, pallid becoming ferruginous cinnamon, white and crenulate on the edge; stem slender, equal, solid, flexuous, tomentosely squamulose, colored like the pileus; spores globose or subellipsoid, nodulose, 6–8 μ in diameter or 8–10 x 8 μ, cystidia ellipsoid, 30–40 x 16–20 μ.

Pileus 1–2 cm broad; stem 2–2.5 cm long, 2 mm thick.

Decaying wood in woods. Saratoga co. August.

European authors do not all agree concerning the character of the spores of this species, describing them as even, angular and acutely warty. In our specimens, which were at first supposed to be distinct, they are as here described. In other characters the

agreement with the description of Inocybe lanuginosa (Bull.) Karst. as given in *Sylloge* is so close that it seems best to refer our plant to this species.

Lacerae

Cuticle of the pileus squamose or fibrillosely lacerated; stem paler than the pileus.

KEY TO THE SPECIES

Spores even..1
Spores angular or nodulose..2
1 Pileus brown, fibrillosely squamulose............................infelix
1 Pileus ochraceous buff, rimosely squamose in the center....squamosodisca
2 Spores angular...maritimoides
2 Spores nodulose...3
3 Pileus brown or grayish brown...............................diminuta
3 Pileus tawny or ochraceous.....................................subfulva

Inocybe infelix Pk.

UNFORTUNATE INOCYBE

Ag. (Inocybe) infelix Pk. N. Y. State Mus. Rep't 32, p.29

Pileus campanulate broadly convex or nearly plane, subumbonate, floccosely squamulose, grayish brown or umber, flesh whitish; lamellae close, adnexed, ventricose, broad, whitish becoming brownish ferruginous; stem equal, solid, silky fibrillose, pallid or whitish above, generally brownish toward the base, pruinose at the top; spores oblong, even, 10–15 x 5–6 μ, cystidia flask shape, 40–60 x 15–20 μ.

Pileus 1.5–2.5 cm broad; stem 2–5 cm long, 2–4 mm thick.

Naked sterile soil or among mosses. Albany, Saratoga, Essex and Hamilton counties. May to August.

Var. **brevipes** Pk. N. Y. State Mus. Bul. 2, p.13.

Pileus scarcely exceeding 1.5 cm broad, stem about 1.5 cm long.

This is a common and variable species, but it is easily recognized by its persistently squamulose brown pileus and its oblong even spores. In wet weather the cuticle of the pileus is often more lacerated than in dry weather. The umbo is sometimes wanting. The plants occur throughout the season when the weather conditions are favorable. It is gregarious in its mode of growth.

Inocybe squamosodisca Pk.

SCALY DISK INOCYBE

N. Y. State Mus. Bul. 75, p.18

Pileus fleshy, firm, convex, fibrillose on the margin, rimosely squamose in the center, ochraceous or ochraceous buff, flesh whitish or yellowish white; lamellae broad, moderately close, adnate, pale ochraceous becoming darker with age; stem equal, solid, fibrillose, colored like or a little paler than the pileus; spores ellipsoid, even, 8–10 x 5–6 μ.

Pileus 2.5–5 cm broad; stem about 2.5 cm long, 4–6 mm thick.

Gregarious. Under pine trees. Hamilton co. August. Rare.

The scales of the pileus are caused by the cracking of the cuticle.

Inocybe maritimoides Pk.

MARITIMOID INOCYBE

N. Y. State Mus. Rep't 38, p.87

Pileus subconic or convex, obtuse or slightly umbonate, densely squamulose in the center, fibrillose on the margin, dark brown; lamellae close, adnexed, ventricose, whitish becoming brownish ochraceous; stem equal, solid, fibrillose, colored like but paler than the pileus; spores irregular, angular, ovate or ellipsoid, 7–9 x 5–6 μ, cystidia 40–55 x 12–20 μ.

Pileus 1.5–2.5 cm broad; stem about 2.5 cm long, 4 mm thick.

Sandy soil in woods. Albany co. October. Rare.

It resembles I n o c y b e m a r i t i m a Fr. but is separated from it by the pileus which is not hygrophanous and by the spores which are smaller and angular but not nodulose.

Inocybe diminuta Pk.

SMALL INOCYBE

N. Y. State Mus. Bul. 105, p.23

Pileus thin, hemispheric becoming convex or nearly plane, squamose with erect or squarrose hairy scales in the center, fibrillose on the margin, grayish brown; lamellae subdistant, broadly sinuate, adnexed, ventricose, whitish becoming rusty brown; stem short, firm, solid, silky fibrillose, whitish above, grayish brown and slightly squamulose toward the base; spores subglobose, nodulose, 8–10 x 6–8 μ, cystidia 40–50 x 12–20 μ.

Pileus 6–12 mm broad; stem 8–16 mm long, 2 mm thick.

Bare compact soil in roads in woods. Suffolk co. August. Rare.

It appears like a dwarf form of Inocybe infelix Pk. but it is very distinct in the character of the spores.

Inocybe subfulva Pk.

TAWNY INOCYBE

N. Y. State Mus. Rep't 41, p.66

Pileus broadly conic or subcampanulate, becoming convex or nearly plane, subumbonate, fibrillosely squamose, tawny ochraceous; lamellae broad, close, adnexed, ventricose, pallid becoming tawny cinnamon; stem equal, firm, solid, fibrous striate, obscurely pruinose. colored like but paler than the pileus; spores globose or ellipsoid, stellately nodulose, 8–10 μ in diameter or 10–12 x 7–8 μ, cystidia 40–80 x 10–15 μ.

Pileus 1.5–3 cm broad; stem 2.5–5 cm long, 2–4 mm thick.

Sandy soil in fields. Albany co. August.

This species is closely allied to Inocybe gaillardi Gill. from which it may be distinguished by its larger size, solid stem and variable spores. The scales of the center of the pileus are often erect but not squarrose.

Rimosae

Pileus radiately fibrillose, soon radiately rimose, sometimes adorned with appressed scales; stem fibrillose, white or whitish or slightly tinged with the color of the pileus.

The species of this section are easily recognized by the radiately cracking of the cuticle of the pileus and the pale color of the stem.

KEY TO THE SPECIES

Spores even.......1
Spores angular or slightly nodulose.......7
Spores distinctly nodulose.......8
1 Pileus umbonate.......2
1 Pileus not umbonate.......5
2 Cuticle peeling in scales or patches.......excoriata
2 Cuticle not peeling.......3
3 Pileus pale brown.......pallidipes
3 Pileus yellowish brown.......rimosa
3 Pileus some other color.......4
4 Pileus fawn color.......eutheles
4 Pileus grayish fawn or chestnut.......eutheloides
5 Pileus yellowish brown.......rimosa

5 Pileus gray or grayish...6
  6 Young lamellae whitish..............................griseoscabrosa
  6 Young lamellae pale violaceous.........................violaceifolia
7 Pileus chestnut color...castanea
7 Pileus brown or dark brown..................................umboninota
7 Pileus brownish with a whitish center............................albodisca
  8 Pileus tawny gray..rigidipes
  8 Pileus brownish...asterospora

Inocybe excoriata Pk.

EXCORIATE INOCYBE

N. Y. State Mus. Bul. 75, p.16, pl.O, fig.14-19

Pileus fleshy, broadly conic becoming broadly convex, umbonate, fibrillose or fibrillosely squamulose, slightly silky or tomentose on the margin, grayish brown, the cuticle often cracking and peeling, flesh white; lamellae close, narrow, adnexed, with a decurrent tooth, white becoming brownish gray, whitish and crenulate on the edge; stem equal, solid, silky fibrillose, white or whitish; spores ellipsoid, even, 8-10 x 5-6 μ, cystidia flask shape, 50-60 x 12-20 μ.

Pileus 2.5-5 cm broad; stem 2.5-5 cm long, 4-6 mm thick.

Among fallen leaves in woods. Hamilton co. August.

The surface of the pileus cracks radiately and thereby indicates the section to which the species belongs. A slight whitish webby veil is present in the young plant.

Inocybe pallidipes E. & E.

PALE STEM INOCYBE

Jour. Myc. 5, p.24

Pileus conic or campanulate becoming expanded, umbonate, fibrillosely squamose, innately or subrimosely scaly on the disk, subrimose on the margin, brown or pale brown; lamellae subclose, rather broad, ascending, becoming ventricose, adnate with a decurrent tooth, pallid becoming clay color or watery cinnamon; stem solid, slightly narrowed and mealy above, loosely fibrillose below, subbulbous, white, white tomentose at the base; spores unequally ellipsoid, even, 7-10 x 5-6 μ, cystidia ventricosely fusoid or flask shape, 40-60 x 14-20 μ.

Pileus 2-3 cm broad; stem 2.5-5 cm long, 2-4 mm thick.

Decaying wood and vegetable mold. Warren co. July.

This species may be recognized by its umbonate pileus and persistently white stem. The umbo is sometimes more highly colored

than the rest of the pileus. From I n o c y b e e u t h e l o i d e s Pk. it may be distinguished by its lamellae and white stem.

Inocybe rimosa (Bull.) Fr.

CRACKED INOCYBE

Sylloge 5:775

Pileus fleshy, thin, broadly conic or campanulate becoming expanded, obtuse or umbonate, silky fibrous, radiately cracking on the surface, yellowish brown; lamellae subclose, adnexed or nearly free, whitish becoming tan color or subferruginous; stem equal, firm, solid, mealy at the top, nearly glabrous, subbulbous, whitish; spores ellipsoid, even, 10–12 x 5–6 μ, cystidia very rare, 60–65 x 15–18 μ.

Pileus 2.5–5 cm broad; stem 2–5 cm long, 4–6 mm thick.

Ground in woods and open places. Albany, Franklin and Ulster counties. August and September.

This is a very variable species but one which is generally recognizable by the radiately cracking of the surface of the pileus.

Var. **parva** Pk. Very small; the pileus rarely more than 2 cm broad, the cuticle obscurely cracking or sometimes continuous.

Var. **cuspidata** Pk. Pileus with a very prominent narrow subacute or cusplike umbo.

Inocybe eutheles (B. & Br.) Sacc.

MAMMILLATE INOCYBE

Sylloge 5:776

Pileus thin, campanulate becoming expanded, distinctly umbonate, silky, shining, subsquamulose, pale fawn color; lamellae rather narrow, adnate, pallid becoming subferruginous, whitish crenulate on the edge; stem slender, solid, equal, fibrous, pallid or whitish; spores ellipsoid, even, 10–15 x 6–8 μ, cystidia very rare, 60–65 x 15–20 μ.

Pileus 2.5–4 cm broad; stem 3–6 cm long, 2–3 mm thick.

Ground. Albany co.

This species has been found but once and is apparently very rare. The European plant is said to have a farinaceous odor and spores 7–10 μ long. In our plant the spores are longer and the odor was not noticed, but in other respects the agreement is fairly good.

Inocybe eutheloides Pk.

EUTHELOID INOCYBE

N. Y. State Mus. Rep't 32, p.29

Pileus thin, campanulate becoming expanded, distinctly umbonate, silky fibrillose, subrimose, varying from grayish cervine to chestnut color, sometimes squamulose on the disk; lamellae close, rather broad, ventricose, narrowed toward the stem, adnexed, whitish becoming brownish ferruginous, white and crenulate on the edge; stem equal, subflexuous, solid, fibrillose, pallid or whitish; spores unequally ellipsoid, uninucleate, even, 8–12 x 5–6 μ, cystidia ventricose, 45–55 x 12–16 μ.

Pileus 1.5–2.5 cm broad; stem 2.5–5 cm long, 2–4 mm thick.

Ground in woods. Onondaga co. September.

This differs from Inocybe eutheles (B. & Br.) Sacc. in its smaller size, darker color, adnexed lamellae, and slightly smaller spores.

Inocybe griseoscabrosa (Pk.) Mass.

GRAYISH INOCYBE

Ag. (Hebeloma) griseoscabrosus Pk. N. Y. State Mus. Rep't 26, p.57

Pileus hemispheric or convex, fibrillosely squamulose, cinereous, with margin whitish when young; lamellae broad, close, whitish becoming brownish ferruginous; stem firm, equal or slightly tapering downward, solid, fibrillose or slightly squamulose, whitish or grayish; spores ellipsoid, even, 9–12 x 5–8 μ, cystidia ventricose, 40–60 x 15–20 μ.

Pileus 1–2 cm broad; stem 3–5 cm long, 2–3 mm thick.

Ground in woods. Albany co. October. Rare.

This small species has been found but once. It is peculiar in having a grayish or cinereous pileus with a white margin.

Inocybe violaceifolia Pk.

VIOLACEOUS GILL INOCYBE

N. Y. State Mus. Rep't 26, p.57

Pileus thin, convex or nearly plane, floccosely fibrillose, subsquamulose, grayish buff; lamellae close, adnexed, pale violaceous becoming pale cinnamon; stem firm, solid, slender, fibrillose, white or whitish; spores ellipsoid, even, 8–10 x 5–6 μ, cystidia 40–60 x 15–20 μ.

Pileus 1–2 cm broad; stem about 2.5 cm long, 2mm thick.

Mossy ground in woods. Albany co. Rare.

This is a small pale species remarkable for the violaceous tint of the young lamellae. Sometimes the pileus is slightly umbonate. A webby veil is present in the young plant.

Inocybe castanea Pk.

CHESTNUT INOCYBE

N. Y. State Mus. Bul. 75, p.16, Pl.O, fig.1–8

Pileus conic or convex, umbonate, radiately rimose, fibrillose, chestnut color; lamellae thin, narrow, close, adnate, whitish becoming brownish ferruginous; stem equal, hollow, subglabrous, pruinose or mealy at the top, often with a whitish tomentum at the base, colored like but paler than the pileus; spores subglobose, angular or slightly nodulose, 6–8 μ in diameter or 8 x 6 μ, cystidia subfusiform, 50–80 x 12–18 μ.

Pileus 1–2 cm broad; stem 2.3–5 cm long, about 2 mm thick.

Mossy ground under spruce and balsam fir trees. Hamilton co. August. Rare.

This is a well marked species and not easily confused with any other.

Inocybe umboninota Pk.

UMBO MARKED INOCYBE

Ag. (Inocybe) umboninotus Pk. N. Y. State Mus. Rep't 38, p.87 in part

Pileus broadly campanulate becoming expanded, umbonate, fibrillose, slightly rimose, dark brown, the umbo sometimes darker than the rest of the pileus; lamellae close, adnate, sometimes slightly sinuate, whitish becoming brownish ferruginous; stem equal or slightly thickened at the base, solid, colored like but paler than the pileus, pruinose at the top; spores subglobose or ellipsoid, very slightly nodulose, 6–8 x 4–6 μ, cystidia 50–60 x 12–20 μ.

Pileus 1.5–2 cm broad; stem 2.5–5 cm long, 2–4 mm thick.

Ground in woods. Ulster co. September.

This species is closely related to Inocybe asterospora Quel. from which it may be separated by its less distinctly rimose pileus and by its smaller less globose and but slightly nodulose spores.

Inocybe albodisca Pk.

WHITE DISK INOCYBE

N. Y. State Mus. Rep't 51, p.290

Pileus conic or campanulate, umbonate, glabrous, whitish in the center when moist, elsewhere yellowish brown or lilac brown, paler when dry, slightly silky fibrillose, radiately rimose; lamellae subclose, adnexed, whitish becoming subferruginous; stem equal, solid, striate, slightly mealy or pruinose at the top, pallid; spores subglobose or ellipsoid, slightly nodulose, 6–8 μ in diameter or 8 x 6 μ, cystidia 40–60 x 14–20 μ.

Pileus 1.5–2.5 cm broad; stem 2–5 cm long, 3–4 mm thick.

Under spruce and balsam fir trees. Essex co. August.

The species is well marked by the whitish umbo or center of the pileus.

Inocybe rigidipes Pk.

RIGID STEM INOCYBE

N. Y. State Mus. Rep't 51, p.289

Pileus thin, convex or subcampanulate becoming convex, umbonate, squamulose, striate and slightly rimose on the margin when dry, tawny gray; lamellae broad, subdistant, narrowed toward the stem, slightly adnexed, tawny ochraceous; stem slender, flexuous, rigid, firm, solid, slightly pruinose, colored like the pileus; spores globose, strongly nodulose, 12 μ in diameter, cystidia 45–60 x 12–16 μ.

Pileus 1.5–2.5 cm broad; stem 3.5–6 cm long, about 2 mm thick.

Damp clay soil in shaded places. Albany co. August. Rare.

This species resembles I n o c y b e s u b f u l v a Pk. from which it may be distinguished by its globose spores and tawny gray pileus. It is also related to I n o c y b e c a l o s p o r a Quel. from which it differs in its tawny gray color, slightly adnexed lamellae, solid flexuous stem and larger spores.

Inocybe asterospora Quel.

STAR SPORE INOCYBE

Sylloge 5: 780

Pileus campanulate becoming expanded, umbonate, radiately rimose, fibrillose, brown or brownish, the umbo often darker than the rest; lamellae close, dull cinnamon; stem equal, subbulbous, sub-

glabrous, solid, whitish or tinged with the color of the pileus; spores subglobose, nodulose, 8–12 μ in diameter, cystidia 40–70 x 12–20 μ.

Pileus 2–3 cm broad; stem 3–6 cm long, 2–3 mm thick.

Ground in woods. Fulton and Rensselaer counties. June and July.

It bears some resemblance to Inocybe rimosa (Bull.) Fr. but from that species it is at once separated by its nodulose subglobose spores. A form with brown cap and prominent umbo was formerly confused with Inocybe umboninota Pk. from which it is also best separated by its spores.

Velutinae

Cuticle of the pileus not cracking, covered with interwoven fibrils, becoming smooth or appressedly squamose, disk even; stem polished, smooth, whitish, mealy at the top.

KEY TO THE SPECIES

	Spores even	1
	Spores slightly nodulose	5
	Spores distinctly nodulose	7
1	Pileus white or whitish, rarely lilac tinted	2
1	Pileus some other color	3
2	Pileus 2–8 mm broad	comatella
2	Pileus 1–2.5 cm broad	geophylla
2	Pileus 2.5–7 cm broad	serotina
3	Pileus pale ochraceous	subochracea
3	Pileus pale tawny or brownish tawny	4
4	Pileus pale tawny, umbonate	agglutinata
4	Pileus brownish tawny, obtuse	subtomentosa
5	Pileus 2.5–5 cm broad	fallax
5	Pileus less than 2.5 cm broad	6
6	Pileus whitish or pallid 1–2 cm broad	paludinella
6	Pileus chestnut or subochraceous, 6–10 mm broad	subexilis
7	Pileus blackish brown with a grayish margin when moist, cinereous when dry	nigridisca
7	Pileus whitish, often with a reddish brown umbo	infida

Inocybe comatella Pk.

HAIRY CAP INOCYBE

N. Y. State Mus. Rep't 38, p.87, pl.2, fig.5–8

Pileus very thin, convex or expanded, clothed with whitish or grayish hairs, fimbriate on the margin; lamellae subdistant, adnexed, cinnamon; stem equal, solid, flexuous, pallid or reddish brown, slightly mealy at the top, slightly flocculose pruinose, with a

whitish mycelial tomentum at the base; spores subellipsoid, even, 8–10 x 5–6 μ, cystidia 45–55 x 12–20 μ

Pileus 4–8 mm broad; stem 1.5–2.5 cm long, about 1 mm thick.

Decaying wood and bark buried under fallen leaves. Fulton co. July. Rare. Found but once.

This is a very small but distinct species remarkable for the hairy covering of the pileus. The hairs on the margin are longer and coarser than the others. The habitat is unusual for an Inocybe.

Inocybe geophylla (Sow.) Fr.

EARTHY LEAF INOCYBE

Sylloge 5:784

Pileus fleshy but thin, conic or ovate becoming expanded, umbonate, silky fibrillose, even, commonly white or whitish, rarely lilac; lamellae close, rather broad, ventricose, adnexed, white becoming clay color; stem equal, firm, stuffed, white, mealy at the top, spores ellipsoid, 8–10 x 4–6 μ, cystidia 40–60 x 12–20 μ.

Pileus 1.5–2.5 cm broad; stem 2.5–6 cm long, 2–4 mm thick.

Ground in woods. Common. August to October.

A fine but small species found mostly in woods and varying some in the color of the pileus. Var. l i l a c i n u s Pk. with lilac colored pileus fading to whitish when old appears to include both A g a r i c u s a f f i n i s Pers. and A g a r i c u s g e o p h i l u s Pers.

Inocybe serotina Pk.

LATE INOCYBE

N. Y. State Mus. Bul. 75, p.17

Pileus fleshy, firm, campanulate or convex becoming nearly plane, fibrillose on the margin, white or yellowish, flesh white; lamellae close, rounded at the stem, slightly adnexed, subventricose, whitish becoming brownish cinnamon; stem subequal, bulbous or sometimes narrowed at the base, solid, fibrous, white; spores oblong or ellipsoid, uninucleate, even, 12–16 x 6–8 μ.

Pileus 2.5–6 cm broad; stem 2.5–6 cm long, 6–12 mm thick.

Sandy soil of Lake Ontario. Wayne co. October. Rare or local. Found but once.

This is one of the largest of our species. Its late appearance in the season is suggestive of the specific name. It is reported by its discoverer, E. B. Burbank, to be edibile.

Inocybe subochracea (Pk.) Mass.

OCHRACEOUS INOCYBE

Ag. (Hebeloma) subochraceus Pk. N. Y. State Cab. Rep't 23, p.95

Pileus thin, conic or convex becoming expanded, commonly umbonate, fibrillosely squamulose, ochraceous yellow; lamellae close, sinuate next the stem, adnexed, whitish becoming ferruginous or brownish ferruginous; stem equal, solid, slightly fibrillose whitish; spores ellipsoid, even, 8–10 x 5–6 μ, cystidia 40–60 x 12–16 μ.

Pileus 2–4 cm broad; stem 1–6 cm long, 2–4 mm thick.

Ground in woods and open places. August to October. Common.

Var. **burtii** Pk. N. Y. State Mus. Rep't 54, p. 167, pl. H, fig. 23–29. Veil distinct, webby, adhering to the margin of the pileus and to the stem, stem long, 5–7.5 cm, fibrillose; mature lamellae darker colored.

Inocybe agglutinata Pk.

AGGLUTINATE INOCYBE

N. Y. State Mus. Rep't 41, p.67

Pileus conic or campanulate becoming convex, umbonate, appressedly fibrillose, sometimes streaked or spotted by the colored fibrils, pale tawny, the umbo very prominent, brown; lamellae close, broad, ventricose, adnexed, whitish becoming brownish cinnamon, usually whitish on the edge; stem firm, solid, pruinose at the top, white or whitish above, tawny or brown toward the base, fibrillose; spores subovate or ellipsoid, even, 10–12 x 5–6 μ, cystidia 40–60 x 16–24 μ.

Pileus 1–2.5 cm broad; stem 2.5–5 cm long, 2–4 mm thick.

Under pine trees. Ulster co. September. Rare.

The fibrils of the pileus appear as if glued to its surface but the pileus is not viscid. The species is very similar to Inocybe whitei B. & Br. in general appearance, but it differs from that species in having a very prominent umbo, in the absence of viscidity from the pileus and in its larger spores.

Inocybe subtomentosa Pk.

SUBTOMENTOSE INOCYBE

N. Y. State Mus. Rep't 48, p.11

Pileus thin, dry, convex or plane, minutely tomentose, brownish tawny; lamellae thin, close, adnate, slightly sinuate, brownish tawny;

stem short, solid, slightly silky fibrillose, colored like or a little paler than the pileus, often with a conspicuous white mycelioid tomentum at the base; spores subellipsoid, even, 8–10 x 5–7 μ.

Pileus 1.5–2.5 cm broad; stem 1.5–2.5 cm long, 2 mm thick.

Gravelly soil among fallen leaves. Clinton co. September. Rare.

This species is related to Inocybe tomentosa E. & E. from which it may be separated by the darker color of the pileus, the absence of an umbo and the larger spores. Its distinguishing features are its small size and minutely tomentose pileus of a uniform brownish tawny color.

Inocybe fallax Pk.

FALLACIOUS INOCYBE

N. Y. State Mus. Bul. 75, p.17. pl.O, fig.20–24

Pileus thin, campanulate or convex, umbonate, obscurely fibrillose, sometimes minutely and obscurely squamulose, whitish or whitish buff, subshining, the margin decurved and often splitting; lamellae thin, close, adnexed, pallid becoming brownish ferruginous; stem equal, flexuous, hollow, minutely mealy or pruinose, whitish; spores angular or slightly nodulose, 8–10 x 6–8 μ, cystidia 40–50 x 15–18 μ.

Pileus 2.5–5 cm broad; stem 5–7.5 cm long, 4–8 mm thick.

Among fallen leaves in woods. Hamilton co. August. Rare.

This species resembles large forms of Inocybe geophylla (Sow.) Fr. from which it may be separated by its spores.

Inocybe paludinella Pk.

MARSH INOCYBE

Ag. (Inocybe) paludinellus Pk. N. Y. State Mus. Rep't 31, p.34

Pileus thin, slightly convex, soon plane, umbonate, subfibrillose, whitish or pallid; lamellae narrow, close, adnate, whitish becoming subferruginous; stem slender, equal, colored like the pileus with a mass of white mycelium at the base; spores subangular, very slightly nodulose, 6–8 x 5–6 μ, cystidia 45–60 x 12–16 μ.

Pileus 1–2 cm broad; stem 2.5–5 cm long, 1–1.5 mm thick.

Gregarious. Low ground and wet places under bushes. Rensselaer co. August. Rare.

This species resembles small forms of Inocybe geophylla (Sow.) Fr. in color, but it is at once separated from that species by its slightly nodulose spores. From Inocybe trechispora

Berk. it differs in its smaller size, more slender stem, and in its pileus being neither viscid when moist nor silky when dry. Its lamellae are adnate and fairly bristle with numerous cystidia.

Inocybe subexilis Pk.

FEEBLE INOCYBE

Ag. (Inocybe) subexilis Pk. N. Y. State Mus. Rep't 38, p.87

Pileus thin, convex or subcampanulate becoming expanded, umbonate, fibrillose on the margin, pale chestnut becoming yellowish or subochraceous; lamellae narrow, close, adnexed, whitish becoming dingy ochraceous; stem equal, slender, flexuous, slightly striate, solid, minutely pruinose, pinkish becoming yellowish; spores subglobose, slightly nodulose, 5–6 μ in diameter, cystidia 45–60 x 12–15 μ.

Pileus 6–10 mm broad; stem 2–2.5 cm long, about 1 mm thick.

Damp mossy ground in woods. Fulton co. July. Rare.

Inocybe nigridisca Pk.

BLACK DISK INOCYBE

N. Y. State Mus. Rep't 41, p.67

Pileus thin, convex becoming nearly plane or centrally depressed, umbonate, minutely fibrillose and blackish brown with a grayish margin when moist, cinereous when dry; lamellae close, rounded at the stem, free or slightly adnexed, grayish becoming brownish ferruginous; stem slender, flexuous, firm, solid, minutely villose pruinose, reddish brown; spores globose or ellipsoid, nodulose, 5–6 μ in diameter or 7–8 x 5–6 μ, cystidia 45–50 x 12–15 μ

Pileus 8–16 mm broad; stem 2.5–4 cm long, about 1 mm thick.

Damp places under ferns. Oswego co. June. Rare.

Its distinguishing features are its blackish brown pileus with grayish margin when moist, fading to cinereous when dry.

Inocybe infida (Pk.) Mass.

UNTRUSTY INOCYBE

Ag. (Inocybe) infidus Pk. N. Y. State Mus. Rep't 27, p.95

Pileus firm, campanulate or expanded, subumbonate, slightly squamulose on the disk, often split on the margin, whitish with umbo or disk often reddish brown; lamellae close, narrow, adnexed, pallid, becoming subcinnamon; stem equal or a little enlarged at

the base, furfuraceous at the top, hollow, white; spores subglobose, nodulose, 8–10 x 6–8 μ, cystidia 40–60 x 12–20 μ.

Pileus 1.5–2.5 cm broad; stem 3–5 cm long, 2–4 mm thick.

Mossy ground in low woods. Essex co. September.

The resemblance of this species to some forms of Inocybe geophylla (Sow.) Fr. is so close that it is important to have a knowledge of its spore characters in order to make a satisfactory determination. The specific name is suggestive of this fact. Sometimes the margin is so abundantly and deeply split that the radiating lobes give a stellate appearance to the pileus. Inocybe commixta Bres., Inocybe umbratica Quel. and Inocybe leucocephala Boud. are given as synonyms of this species by Massee.

This species has been reported as having caused a slight temporary illness in some members of a family who had specimens of it prepared for the table and partook of them. It is well therefore to consider it a poisonous or at least an unwholesome species.

Viscidae

Pileus viscid becoming smooth.

This section connects the genus Inocybe with the genus Hebeloma, the viscid pileus being common to it and Hebeloma. The character, "becoming smooth," does not rigidly apply in all cases, for in some of the species the pileus is more or less persistently silky or fibrillose or hairy on the margin.

KEY TO THE SPECIES

Spores globose or subglobose............................tricholoma
Spores not globose..1
1 Spores nodulose ....trechispora
1 Spores not nodulose..2
2 Pileus blackish brown in the center.......................fuscodisca
2 Pileus not blackish brown in the center................vatricosoides

Inocybe tricholoma (A. & S.) Fr.

HAIRY MARGIN INOCYBE

Paxillus strigosus Pk. N. Y. State Mus. Rep't 26, p.63

Pileus thin, broadly convex becoming nearly plane or slightly depressed in the center, subviscid, slightly hairy, specially on the subciliate margin, whitish; lamellae close, narrow, decurrent, whitish becoming brownish or subferruginous; stem equal, stuffed or solid,

pruinose, whitish; spores subglobose, even or minutely nodulose, 4–5 μ in diameter.

Pileus 2–3 cm broad; stem 4–5 cm long, 2–3 mm thick.

Ground among fallen leaves in woods. Lewis co. September.

This is a rare species which departs from the generic character in its decurrent lamellae. It is unlike any of our other species of Inocybe in its minute globose spores. These have been described in *Sylloge* as echinulate, but in our plant the spores appear even under ordinary magnification, most minutely uneven under higher power or better definition. By some, the species has been referred to the genus Flammula. It has also been taken as the type species of a genus Ripartites, instituted by Karsten to include all the species of this section.

Inocybe trechispora (Berk.) Karst.

ROUGH SPORE INOCYBE

Ag. (Hebeloma) trechisporus Berk. Outl. B. Fungi. p.156

Pileus thin, convex, acutely umbonate, at first viscid, then dry and silky, whitish with the umbo yellowish; lamellae subdistant, ventricose, sinuate, whitish becoming subferruginous; stem equal, slightly striate, stuffed, mealy, whitish; spores subglobose or ellipsoid, nodulose, 6–8 μ in diameter or 7–8 x 5–6 μ, cystidia 40–50 x 12–20 μ.

Pileus 2–3 cm broad; stem 2.5–5 cm long, 2–5 mm thick.

Ground in woods. Herkimer and Onondaga counties. August.

Inocybe fuscodisca (Pk.) Mass.

BROWN DISK INOCYBE

Ag. (Hebeloma) fuscodisca Pk. N. Y. State Mus. Rep't 27, p. 95. pl.1, fig.3–6

Pileus conic becoming campanulate or expanded, umbonate slightly viscid, fibrillose, whitish, blackish brown on the umbo; lamellae close, adnexed, whitish becoming brownish ferruginous, white crenulate on the edge; stem equal, solid, whitish pruinose at the top, fibrillose below, brownish; spores ellipsoid, even, 8–10 x 5–6 μ, cystidia 40–70 x 12–20 μ.

Pileus 1.5–2.5 cm broad; stem 2.5–7 cm long, 2–4 mm thick.

Ground under trees. Sullivan co. September. Rare.

The viscid pellicle is separable. The odor resembles that of chestnut blossoms.

Inocybe vatricosoides n. sp.

VATRICOSOID INOCYBE

Pileus thin, convex becoming nearly plane, slightly viscid when moist, obtuse or subumbonate, fibrillose on the margin from the abundant whitish webby veil, whitish, often reddish in the center, flesh whitish, odor like that of radishes; lamellae close, broadly sinuate, adnate with a decurrent tooth, whitish becoming brownish ferruginous, white crenulate on the edge; stem equal, flexuous usually curved at the base, stuffed or hollow, silky fibrillose, whitish or grayish, sometimes with whitish floccose scales toward the base; spores ellipsoid, even, 10–12 x 6–8 μ.

Pileus 2–3 cm broad; stem 2.5–5 cm long, 2–6 mm thick.

Damp ground under willows. Ulster co. September.

This species is closely allied to Inocybe vatricosa Fr. to which it was referred in New York State Museum Report 41, page 67, but from which it is here separated because of its well developed webby veil, its radishlike odor, its adnate lamellae, its silky fibrillose stem and its larger spores.

Pileus tenuis, convexus, deinde subplanus, dum humidus subviscidus, obtusus subumbonatusve, margine velo abundante albido arachnoideo fibrillosus, albidus saepe centro rufescens, carne albida, odore Raphani; lamellae confertae, late sinuatae, adnatae, albidae deinde fusco-ferrugineae, acie albae crenulatae; stipes aequalis, flexuosus, saepe basi curvatus, farctus fistulosusve, sericeo-fibrillosus, aliquando infra squamulis albis floccosis ornatus, albidus vel griseus; sporae ellipsoideae, leves, 10–12 x 6–8 μ.

Inocybe radiata Pk. N. Y. State Mus. Bul. 105, p. 24. The Port Jefferson specimens referred to this species as a small form are rather a small form of Inocybe asterospora Quel.

NEW YORK SPECIES OF HEBELOMA

Hebeloma Fr.

Veil partial, fibrillose or obsolete; stem fleshy fibrous, somewhat mealy at the apex; margin of the pileus at first incurved, the cuticle continuous, glabrous, subviscid; lamellae sinuate, adnexed, usually whitish on the edge; spores subargillaceous. *Sylloge* 5:791

This genus formerly included the species now referred to Inocybe. It differs from it specially in its partial veil and in its continuous, subviscid and glabrous cuticle. Some of the species have a peculiar radishlike odor. The spores in all our species are even. As in the

preceding genus, most of the species are terrestrial. They have been placed in two primary divisions, Exannulata and Subannulata. Our species fall in the Exannulata division which has been divided into three sections, the principal characters of which are indicated in the following key.

KEY TO THE SECTIONS

Pileus more than 3.5 cm broad	1
Pileus less than 3.5 cm broad	Pusilla
1 Veil present	Indusiata
1 Veil absent	Denudata

Indusiata

Veil evident, webby, often making the margin of the pileus superficially silky.

KEY TO THE SPECIES

Pileus glutinous and squamose	glutinosum
Pileus viscid, not squamose	1
1 Stem commonly showing fragments of an annulus	velatum
1 Stem not at all annulate	2
2 Pileus umbonate	firmum
2 Pileus not umbonate	3
3 Spores 6–8 long	parvifructum
3 Spores 10–12 long	4
4 Stem white, fibrous squamulose	fastibile
4 Stem whitish or subochraceous, fibrillose	pascuense

Hebeloma glutinosum (Lindgr.) Fr.

GLUTINOUS HEBELOMA

Sylloge 5:793

Pileus fleshy, convex becoming plane, glutinous, sprinkled with white superficial squamules, yellowish white, flesh white or whitish; lamellae close, sinuate, adnexed, yellowish becoming dingy cinnamon; stem equal or slightly thickened at the base, firm, stuffed, mealy at the top, fibrillose squamulose, whitish, somewhat ferruginous within; spores ellipsoid, 10–12 x 5–6 μ.

Pileus 2.5–7 cm broad; stem 4–8 cm long, 4–8 mm thick.

Ground in woods. Essex and Warren counties. September and October.

This species is easily recognized by its very viscose or glutinous pileus with its superficial white scales. These are not persistent and consequently specimens may be found without any scales.

Hebeloma velatum Pk.

VEILED HEBELOMA

Hebeloma colvini Pk., var. velatum Pk. N. Y. State Mus. Rep't 48, p.19

Pileus convex, plane or slightly centrally depressed, obtuse or umbonate, slightly viscid when moist, glabrous or slightly silky from the veil which may disappear with age or persist and make the margin silky or floccosely scaly or appendiculate with its fragments, chestnut color, reddish gray, pale ochraceous or grayish; lamellae close, ventricose, adnexed, whitish becoming pale cinnamon, whitish and often crenulate on the edge; stem equal, hollow, silky fibrillose, sometimes floccosely squamulose toward the base, often more or less annulate, the soft cottony whitish or grayish veil rupturing and adhering partly to the stem and partly to the margin of the pileus, whitish; spores subellipsoid, 10–12 x 6–8 μ.

Pileus 1.5–6 cm broad; stem 1.5–6 cm long, 4–6 mm thick.

Gregarious or cespitose. Gravelly soil under cottonwood trees. Clinton co. September.

This is an extremely variable species and shows how difficult it may be with a limited number of specimens in such cases to locate them correctly. All the forms here included under one name were collected at the same time and place, in a limited area but a few feet in diameter. They are without doubt all one species. Their general appearance suggested such a close relationship to Hebeloma colvini Pk. that it was thought best to group them all under that species as a variety distinguished chiefly by its more fully developed veil. If only the form having the veil and annulus in their most highly developed condition had been seen, the species might easily have been referred to the genus Pholiota. Even with those in which only fragmentary vestiges of the veil adhere to the stem its natural place would seem to be in the Subannulata division of the genus Hebeloma. But other forms show no trace of an annulus and compel us to be more conservative in our assignment of this perplexing species. It is therefore placed where the more abundant forms and less strongly developed or silky fibrillose veil would require it to go. It differs from Hebeloma strophosum Fr. in its great variability, differently colored pileus, radishlike odor and specially in the whitish color of the young lamellae.

Hebeloma firmum (Pers.) Fr.

FIRM HEBELOMA

Sylloge 5:793

Pileus fleshy, convex or campanulate becoming expanded, umbonate, viscid, fibrillose, brick red with paler margin; lamellae close, rounded behind, adnexed, tan color becoming subferruginous; stem equal or nearly so, solid or with a small cavity, floccosely squamulose, whitish sometimes becoming subferruginous toward the base; spores subellipsoid, 10–12 x 5–6 μ.

Pileus 5–7 cm broad; stem 4–6 cm long, 6–8 mm thick.

Mossy ground in low woods. Essex co. September.

Hebeloma parvifructum Pk.

SMALL FRUIT HEBELOMA

Ag. (Hebeloma) parvifructus Pk. N. Y. State Mus. Rep't 38, p.88

Pileus convex becoming expanded, slightly viscid, whitish, grayish brown or pale chestnut, often paler on the margin; lamellae moderately close, slightly sinuate, white becoming dingy ochraceous, at first hidden by the copious white webby filaments of the veil; stem equal, often flexuous, solid, silky fibrillose, pruinose and substriate at the top, whitish above, ferruginous or brownish toward the base; spores subochraceous, 6–7 x 4–5 μ.

Pileus 5–7 cm broad; stem 5–8 cm long, 6–8 mm thick.

Sandy soil in pine woods. Albany co. October.

The small spores are suggestive of the specific name.

Hebeloma fastibile Fr.

OCHERY HEBELOMA

Sylloge 5:792

Pileus convex or nearly plane, compact, often wavy, obtuse, viscid when young, whitish, yellowish or tan color, flesh white, odor similar to that of radishes, taste bitterish, veil webby, distinct; lamellae sinuate, adnexed, subdistant, whitish or pallid becoming cinnamon, whitish on the edge; stem equal, solid, fibrous, firm, sometimes slightly bulbous, white; spores ellipsoid, 10–12 x 5–6 μ.

Pileus 3–7 cm broad; stem 5–7 cm long, 5–10 mm thick.

Ground in woods. Albany and Ulster counties. October.

A small white form, perhaps var. alba Sacc., has been found in Albany county.

Hebeloma pascuense Pk.

PASTURE HEBELOMA

N. Y. State Mus. Rep't 53, p.844, pl.C, fig.21–27

Pileus thin, convex becoming nearly plane, viscid when moist, obscurely innately fibrillose, brownish clay color, often darker or rufescent in the center, the margin when young often whitened by the thin webby veil, flesh whitish, odor similar to that of radishes; lamellae close, adnexed, whitish becoming pale ochraceous; stem firm, equal, solid, fibrillose, slightly mealy at the top, whitish or pallid; spores pale ochraceous, subellipsoid, uninucleate 10 x 6 η.

Pileus 2.5–5 cm broad; stem 2.5–5 cm long, 4–6 mm thick.

Gregarious or subcespitose. Stony pastures. Warren co. October.

Closely related to Hebeloma fastibile Fr. but a smaller species with a more slender stem, a different habit and habitat, differently colored pileus and more crowded lamellae. Sometimes a narrow brown zone or line encircles the pileus near the margin.

Denudata

Pileus glabrous, veil absent from the first.

The species are easily distinguished from those of the preceding section by the entire absence of a veil.

KEY TO THE SPECIES

	Pileus white or whitish	1
	Pileus some other color	3
1	Lamellae dingy flesh color	sarcophyllum
1	Lamellae white or whitish becoming dingy ferruginous	2
2	Pileus white or yellowish white	album
2	Pileus whitish or grayish white	albidulum
3	Plant having a radishlike odor	crustuliniforme
3	Plant not having a radishlike odor	4
4	Plant growing in sandy soil in open places	colvini
4	Plant growing in woods	longicaudum

Hebeloma sarcophyllum Pk.

PINK GILL HEBELOMA

Ag. (Hebeloma) sarcophyllus Pk. N. Y. State Cab. Rep't 23, p.96, pl.1, fig.7–11

Pileus fleshy, obtusely conic or convex, glabrous, white, flesh white, taste bitterish; lamellae subclose, adnexed, deeply sinuate, dingy flesh color; stem equal, firm, stuffed, mealy or minutely

squamulose at the top, white; spores dark ferruginous, subellipsoid, 8–10 x 5–6 μ.

Pileus 1.5–3 cm broad; stem 2.5–4 cm long, 2–4 mm thick.

Grassy ground. Rensselaer co. June. Rare.

A species well marked by the peculiar color of the lamellae which at first suggests a species of Agaricus.

Hebeloma album Pk.

WHITE HEBELOMA

N. Y. State Mus. Rep't 54, p.147, pl.G, fig.1–7

Pileus fleshy, firm, convex becoming nearly plane or concave by the margin curving upward, glabrous, subviscid, white or yellowish white, flesh white; lamellae thin, narrow, close, sinuate, adnexed, whitish becoming brownish ferruginous; stem equal, firm, rather long, solid or stuffed, slightly mealy at the top, white; spores subellipsoid, pointed at one or both ends, 12–16 x 6–8 μ.

Pileus 2.5–5 cm broad; stem 3.5–7 cm long, 4–6 mm thick.

Among fallen leaves in woods. Essex co. October.

Easily recognized by the white color of both pileus and stem. A new figure of this species is given in the present report on plate 117, figure 1–6.

Hebeloma albidulum Pk.

WHITISH HEBELOMA

N. Y. State Mus. Rep't 54, p.148

Pileus fleshy, firm, broadly convex or nearly plane, glabrous, slightly viscid when moist, dingy white or grayish white, flesh white; lamellae close, narrow, adnexed, whitish becoming brownish ferruginous, white and minutely denticulate on the edge; stem equal, firm, glabrous, slightly mealy or pruinose at the top, hollow, sometimes slightly bulbous, colored like the pileus; spores subellipsoid, obtuse, 10–12 x 6–8 μ.

Pileus 2.5–6 cm broad; stem 3–6 cm long, 4–6 mm thick.

Among fallen leaves in woods. Essex co. October.

This differs from Hebeloma album Pk. in its more dingy color, its hollow stem and its shorter and more obtuse spores.

Hebeloma crustuliniforme (Bull.) Fr.

CRUSTULINE HEBELOMA

Sylloge 5:799

Pileus fleshy, convex becoming plane, obtuse or with an obtuse umbo, even, glabrous, slightly viscid when young, whitish tan or brick red, odor like that of radishes; lamellae close, adnexed, narrow, thin, whitish becoming clay color or brownish ferruginous; stem equal, stuffed or hollow, subbulbous, white squamulose at the top, whitish; spores ellipsoid, unequal, 10–12 x 5–7 μ.

Pileus 4–6 cm broad; stem 4–5 cm long, 6–10 mm thick.

Ground in woods or open places. Cattaraugus and Ulster counties. September.

Hebeloma colvini Pk.

COLVIN HEBELOMA

Ag. (Hebeloma) colvini Pk. N. Y. State Mus. Rep't 28, p.49

Pileus fleshy, convex or nearly plane, sometimes gibbous or broadly umbonate, rarely centrally depressed, glabrous, grayish or alutaceous with an ochraceous tint; lamellae close, broad, sinuate, adnexed, whitish becoming brownish ochraceous; stem equal, flexuous, silky fibrillose, stuffed or hollow above, solid toward the base, whitish; spores subellipsoid, 10–12 x 5–6 μ.

Pileus 2.5–7.5 cm broad; stem 2.5–8 cm long, 2–6 mm thick.

Sandy soil in open places. Albany co. October.

The mycelium binds the sand into a globose mass which adheres to the base of the stem.

Hebeloma longicaudum (Pers.) Fr.

LONG STEM HEBELOMA

Sylloge 5:800

Pileus fleshy, convex becoming expanded, glabrous, viscid, whitish, argillaceous or tan color, sometimes brownish or yellowish red on the disk; lamellae close, sinuate near the stem, adnexed, whitish and serrulate on the edge, tan color becoming dingy cinnamon; stem unequal, rather long, fragile, partly hollow, mealy at the top, obsoletely fibrillose, white; spores oblong or ellipsoid, 10–12 x 6–8 μ.

Pileus 3.5–6 cm broad; stem 5–9 cm long, 5–8 mm thick.

Ground in woods. Catskill mountains. September.

A rare species in our State.

Pusilla

Pileus small, less than 3.5 cm broad.

Several species have been referred to this section that have not a viscid pileus, but in some it is moist.

KEY TO THE SPECIES

Pileus slightly viscid when moist 1
Pileus not viscid when moist 4
1 Pileus white or yellowish white .... **sociale**
1 Pileus some other color 2
2 Pileus ochraceous yellow .... **gregarium**
2 Pileus tawny brown or reddish brown 3
3 Stem 2.5 cm long, center of pileus not changing color .... **sordidulum**
3 Stem longer, center of pileus changing color with age or in drying .... **discomorbidum**
4 Pileus hygrophanous when moist 5
4 Pileus not hygrophanous when moist 7
5 Stem white .... **palustre**
5 Stem not white 6
6 Pileus uniformly brown .... **illicitum**
6 Pileus brown with a whitish or pallid margin .... **pallidomarginatum**
7 Pileus broadly umbonate, stem solid .... **excedens**
7 Pileus not umbonate, stem hollow .... **fragilius**

Hebeloma sociale Pk.

SOCIAL HEBELOMA

N. Y. State Mus. Bul. 75, p.15

Pileus fleshy but thin, convex becoming plane or nearly so, glabrous, slightly viscid when moist, yellowish white, flesh yellowish white, taste nauseous; lamellae thin, close, adnexed, whitish, then yellowish, finally brownish ferruginous; stem short, fibrous, floccose fibrillose, hollow, white; spores brownish ferruginous, ellipsoid, 6–8 x 4–5 μ.

Pileus 2–3 cm broad; stem 2.5–3.5 cm long, 3–6 mm thick.

Gregarious or subcespitose. Among short grass in pastures. Albany co. October.

This is distinguished from our other white or whitish species by its peculiar habitat and its small spores.

Hebeloma gregarium Pk.

GREGARIOUS HEBELOMA

N. Y. State Mus. Rep't 49, p.18

Pileus thin, hemispheric or convex, obtuse or rarely with a small inconspicuous umbo, slightly viscid when moist, glabrous or slightly silky on the margin, pale ochraceous, sometimes with a reddish or tawny tint in the center, flesh whitish; lamellae thin, close, adnate, whitish becoming subcinnamon; stem slender, stuffed or hollow, fibrillose, whitish, slightly mealy or pruinose at the top; spores ellipsoid, 10–11 x 5–6 μ.

Pileus 2–3.5 cm broad; stem 3–5 cm long, 2–4 mm thick.

Sandy soil in heathy places. Albany co. October. Rare.

The pileus is sometimes split on the margin in such a way as to cause it to appear stellately lobed. A slight radishlike odor is perceptible when the pileus is cut or broken. The plants are gregarious.

Hebeloma sordidulum Pk.

SLIGHTLY SORDID HEBELOMA

Ag. (Hebeloma) sordidulus Pk. N. Y. State Mus. Rep't 38, p.88

Pileus thin, firm, viscid when moist, convex, brownish red or tawny brown, paler on the margin, flesh white, with a radishlike odor; lamellae broad, close, rounded behind, slightly adnexed, pallid becoming brownish ochraceous; stem short, equal, stuffed or hollow, slightly fibrillose, pruinose at the top, white; spores subellipsoid, 12–15 x 6–7 μ.

Pileus 2–4 cm broad; stem about 2.5 cm long, 3–4 mm thick.

Sandy soil in open bushy places. Albany co. October. Rare.

Hebeloma discomorbidum Pk.

DISK DISEASED HEBELOMA

Ag. (Naucoria) discomorbidus Pk. N. Y. State Mus. Rep't 26, p.58

Pileus thin, broadly convex or nearly plane, glabrous, slightly viscid, reddish brown or chestnut color becoming brown in the center with age or in drying; lamellae close, narrow, white or pallid becoming brownish ferruginous, white and crenulate on the edge; stem equal, stuffed or hollow, slightly mealy at the top, white; spores ellipsoid, uninucleate, 10 x 6 μ.

Pileus 2–4 cm broad; stem 4–6 cm long, 2–4 mm thick.

Ground in woods. Lewis and Columbia counties. September and October.

In the dried specimens the center of the pileus has a brown or discolored appearance as if beginning to decay. This is suggestive of the specific name.

Hebeloma palustre Pk.

MARSH HEBELOMA

N. Y. State Mus. Bul. 25, p.649

Pileus thin, broadly convex becoming nearly plane, sometimes wavy or irregular, glabrous, hygrophanous, grayish brown and slightly striatulate on the margin when moist, paler when dry, flesh whitish; lamellae close, thin, ventricose, adnexed, grayish white becoming brownish cinnamon; stem equal or tapering upward, hollow, silky, white; spores subellipsoid, uninucleate, 10–12 x 6–8 μ.

Pileus 2.5–3.5 cm broad; stem 5–7 cm long, 4–8 mm thick.

Mossy ground in swampy woods. Oswego co. October. Rare.

Hebeloma illicitum Pk.

UNLAWFUL HEBELOMA

Ag. (Hebeloma) illicitus Pk. N. Y. State Mus. Rep't 24, p.68, pl.4, fig.1–5

Pileus fleshy, firm, convex or expanded, obtuse, glabrous, hygrophanous, dark brown when moist, paler when dry; lamellae close, broad, ventricose, adnexed, pale brown; stem equal, firm, hollow, striate at the top, with a white mycelium at the base, colored like but paler than the pileus; spores subellipsoid, 8–10 x 4–5 μ.

Pileus 2.5–3.5 cm broad; stem 3.5–5 cm long, 4 mm thick.

Decaying wood and sticks in woods. Lewis and Washington counties. September. Rare.

Gregarious or cespitose. The specific name has reference to its habitat, which is unusual for species of this genus.

Hebeloma pallidomarginatum Pk.

PALE MARGIN HEBELOMA

Ag. (Hebeloma) pallidomarginatus Pk. N. Y. State Mus. Rep't 25, p.78

Pileus broadly convex, sometimes irregular, glabrous, hygrophanous, brown with a pale margin when moist, ochraceous and subatomaceous when dry; lamellae close, thin, adnexed, brownish ochraceous; stem commonly long and flexuous, equal or tapering upward, hollow, white floccose at the base, colored like but paler than the pileus; spores subellipsoid, 10 x 5 μ.

Pileus 1-2.5 cm broad; stem 2.5-7 cm long, 2 mm thick.

Gregarious in swamps and wet places. Rensselaer co. September. Rare.

Hebeloma excedens Pk.

THIN MARGIN HEBELOMA

Ag. (Hebeloma) excedens Pk. N. Y. State Mus. Rep't 24, p.68

Pileus thin, convex, obtuse or broadly umbonate, glabrous, pale alutaceous, the margin surpassing the lamellae, taste and odor like that of radishes; lamellae close, deeply sinuate, adnexed, moderately broad, minutely eroded on the edge, pallid becoming brownish ferruginous; stem equal, solid, silky, fibrillose, colored like the pileus; spores subellipsoid, 10-12 x 6-7 μ.

Pileus 1.5-2.5 cm broad; stem 3-5 cm long, 2-4 mm thick.

Sandy soil under or near pine trees. Saratoga co. October. Very rare. Not found since 1870.

Easily known by its thin margin which extends beyond the lamellae.

Hebeloma fragilius Pk.

FRAGILE HEBELOMA

Ag. (Hebeloma) fragilior Pk. N. Y. State Mus. Rep't 27, p.95

Pileus thin, fragile, convex becoming plane or centrally depressed, sometimes irregular or wavy on the margin, minutely squamulose when young, soon glabrous, pale grayish ochraceous; lamellae subdistant, ventricose, adnexed, whitish and crenulate on the edge, subochraceous; stem slender, equal, hollow, minutely furfuraceous becoming glabrous, colored like the pileus; spores ellipsoid, 6 x 4 μ.

Pileus 6-12 mm broad; stem about 2.5 cm long, 1-2 mm thick.

Damp decaying leaves in wet places in swamps. Hamilton co. July. Rare.

This is a very small species and in habitat is unlike any other of our species. Sometimes the stem is expanded at the base in a thin disk closely applied to the matrix. It needs further investigation and may possibly be found to be a species of Naucoria.

Ag. (Hebeloma) lacerus Fr. N. Y. State Cab. Rep't 23, p. 95 is referable to Inocybe asterospora Quel.

Ag. (Hebeloma) flocculosus Berk. N. Y. State Cab. Rept 23, p. 96 is referable to Inocybe infelix Pk.

Ag. (Hebeloma) ascophorus Pk. N. Y. State Mus. Rep't 24, p. 68 is erroneously described and is referable to Flammula highlandensis Pk.

LIST OF EDIBLE, POISONOUS AND UNWHOLESOME MUSHROOMS HITHERTO FIGURED AND DESCRIBED BY C. H. PECK, STATE BOTANIST

Agaricus abruptus *Pk.*
N. Y. State Mus. Mem. 4, p.163–64, pl.59, fig.8–14. 1900. (Agaricus abruptibulbus *Pk.* N. Y. State Mus. Bul. 94, p.36. 1905)

Agaricus arvensis *Schaeff.*
N. Y. State Mus. Rep't 48, p.140–41, pl.8. 1896. Bot. ed.

Agaricus campester *L.*
N. Y. State Mus. Rep't 48, p.134–37, pl.6. 1896. Bot. ed.

Agaricus diminutivus *Pk.*
N. Y. State Mus. Rep't 54, p.184–85, pl.74, fig.1–8. 1901

Agaricus haemorrhoidarius *Schulz.*
N. Y. State Mus. Rep't 54, p.183–84, pl.75. 1901

Agaricus micromegethus *Pk.*
(Agaricus pusillus *Pk.* N. Y. State Mus. Rep't 54, p.152. 1901)
N. Y. State Mus. Bul. 116, p.44, pl.107, fig.1–6. 1907

Agaricus placomyces *Pk.*
N. Y. State Mus. Rep't 48, p.142–43, pl.9, fig.7–12. 1896. Bot. ed.

Agaricus rodmani *Pk.*
N. Y. State Mus. Rep't 48, p.137–38, pl.9, fig.1–6. 1896. Bot. ed.

Agaricus silvicola *Pk.*
N. Y. State Mus. Mem. 4, p.164–65, pl.59, fig.1–7. 1900

Agaricus subrufescens *Pk.*
N. Y. State Mus. Rep't 48, p.138–40, pl.7. 1896. Bot. ed.

Amanita caesarea *Scop.*
N. Y. State Mus. Rep't 48, p. 155–57, pl.15. 1896. Bot. ed.

Amanita rubescens *Fr.*
N. Y. State Mus. Rep't 48, p.157–59, pl.16. 1896. Bot. ed.

Amanitopsis strangulata *(Fr.) Roze*
N. Y. State Mus. Rep't 51, p.300–2, pl.50, fig.1–10. 1898
N. Y. State Mus. Mem. 4, p.134–35, pl.44, fig.1–10. 1900

Amanitopsis vaginata *Roze*
N. Y. State Mus. Rep't 48, p.159–60, pl.17. 1896. Bot. ed.

Armillaria mellea *Vahl*
N. Y. State Mus. Rep't 48, p.164–67, pl.20. 1896. Bot. ed.

Boletinus grisellus *Pk.*
N. Y. State Mus. Mem. 4, p.169, pl.52, fig.13–19. 1900

Boletinus pictus *Pk.*
N. Y. State Mus. Bul. 25, p.681–82, pl.61, fig.1–5. 1899
N. Y. State Mus. Mem. 4, p.169, pl.61, fig.1–5. 1900

Boletus affinis *Pk.*
N. Y. State Mus. Rep't 49, p.64, pl.48, fig.6–16. 1896. Bot. ed.
N. Y. State Mus. Mem. 4, p.174–75, pl.66, fig.7–14. 1900

Boletus bicolor *Pk.*
N. Y. State Mus. Bul. 54, p.973–74, pl.81, fig.6–11. 1902

Boletus brevipes *Pk.*
N. Y. State Mus. Rep't 49, p.63–64, pl. 48, fig.1–5. 1896. Bot. ed.
N. Y. State Mus. Mem. 4, p.174, pl.66, fig.1–6. 1900
Boletus castaneus *Bull.*
N. Y. State Mus. Rep't 48, p.201–2, pl.36, fig.1–7. 1895. Bot. ed.
Boletus chrysenteron albocarneus *Pk.*
N. Y. State Mus. Rep't 54, p.185–86, pl.76, fig.21–25. 1901
Boletus clintonianus *Pk.*
N. Y. State Mus. Bul. 25, p.682, pl.61, fig.6–10. 1899
N. Y. State Mus. Mem. 4, p.170–71, pl.63. 1900
Boletus edulis *Bull.*
N. Y. State Mus. Rep't 47, p.200–1, pl.36, fig.8–12. 1896. Bot. ed.
Boletus edulis clavipes *Pk.*
N. Y. State Mus. Rep't 51, p.309–10, pl.54. 1898
N. Y. State Mus. Mem. 4, p.173–74, pl.65. 1900
Boletus eximius *Pk.*
N. Y. State Mus. Bul. 54, p.976–77, pl.80, fig.6–12. 1902
Boletus frostii *Russell*
N. Y. State Mus. Bul. 116, p.44–45, pl.108. 1907
Boletus granulatus *L.*
N. Y. State Mus. Rep't 48, p.196–97, pl.34, fig.1–5. 1896. Bot. ed.
Boletus laricinus *Berk.*
N. Y. State Mus. Bul. 94, p.46–47, pl.89. 1905
Boletus luteus *L.*
N. Y. State Mus. Rep't 48, p.195–96, pl.33, fig.7–12. 1896. Bot. ed.
Boletus niveus *Fr.*
N. Y. State Mus. Bul. 122, p.140–41, pl.113. 1908
Boletus nobilis *Pk.*
N. Y. State Mus. Bul. 94, p.48, pl.91. 1905
Boletus ornatipes *Pk.*
N. Y. State Mus. Bul. 54, p.975–76, pl.80, fig.1–5. 1902
Boletus pallidus *Frost*
N. Y. State Mus. Bul. 54, p.974–75, pl.81, fig.1–5. 1902
Boletus rubropunctus *Pk.*
N. Y. State Mus. Bul. 94, p.47, pl.90. 1905
Boletus rugosiceps *Pk.*
N. Y. State Mus. Bul. 116, p.45. 1907
N. Y. State Mus. Bul. 94, p.20–21, pl.Q, fig.6–10. 1905
Boletus scaber *Fr.*
N. Y. State Mus. Rep't 48, p.199–200, pl.35. 1896. Bot. ed.
Boletus spectabilis *Pk.*
N. Y. State Mus. Mem. 4, p.171–72, pl.62. 1900
Boletus subaureus *Pk.*
N. Y. State Mus. Mem. 4, p.169–70, pl.61, fig.6–13. 1900
Boletus subglabripes *Pk.*
N. Y. State Mus. Rep't 51, p.308–9, pl.55. 1898
N. Y. State Mus. Mem. 4, p.172–73, pl.64. 1900
Boletus subluteus *Pk.*
N. Y. State Mus. Rep't 48, p.196, pl.33, fig.1–6. 1895. Bot. ed.

Boletus versipellis *Fr.*
N. Y. State Mus. Rep't 48, p.198, pl.34, fig.6–10. 1896. Bot. ed.
Bovista pila *B. & C.*
N. Y. State Mus. Bul. 75, p.34, pl.84, fig.14–18. 1904
Bovista plumbea *Pers.*
N. Y. State Mus. Bul. 54, p.977–78, pl.81, fig.12–19. 1902
Cantharellus cibarius *Fr.*
N. Y. State Mus. Rep't 48, p.190–91, pl.32. 1896. Bot. ed.
Cantharellus cinnabarinus *Schw.*
N. Y. State Mus. Bul. 25, p. 679–680, pl.60, fig.1–9. 1899
N. Y. State Mus. Mem. 4, p.155–56, pl.55, fig.1–8. 1900
Cantharellus dichotomus *Pk.*
N. Y. State Mus. Bul. 67, p.46–47, pl.84, fig.8–21. 1903
Cantharellus floccosus *Schw.*
N. Y. State Mus. Bul. 25, p.680–81, pl.60, fig.10–14. 1899
N. Y. State Mus. Mem. 4, p.156–57, pl.55, fig.9–13. 1900
Cantharellus infundibuliformis *(Scop.) Fr.*
N. Y. State Mus. Mem. 4, p.158–59, pl.56, fig.9–16. 1900
Cantharellus lutescens *Fr.*
N. Y. State Mus. Mem. 4, p.157–58, pl.56, fig.1–8. 1900
Cantharellus minor *Pk.*
N. Y. State Mus. Bul. 131, p.41–42, pl.116, fig.12–17. 1909
Clavaria botrytis *Pers.*
N. Y. State Mus. Rep't 48, p.211, pl.39, fig.5–7. 1896. Bot. ed.
Clavaria botrytoides *Pk.*
N. Y. State Mus. Bul. 94, p.49, pl.93, fig.5–7. 1905
Clavaria conjuncta *Pk.*
N. Y. State Mus. Bul. 105, p.42–43, pl.102. 1906
Clavaria cristata *Pers.*
N. Y. State Mus. Rep't 48, p.211–12, pl.39, fig.8–12. 1896. Bot. ed.
Clavaria flava *Schaeff.*
N. Y. State Mus. Rep't 48, p.210, pl.39, fig.1–4. 1896. Bot. ed.
Clavaria pistillaris *L.*
N. Y. State Mus. Bul. 94, p.50, pl.93, fig.1–4. 1905
Clavaria pistillaris umbonata *Pk.*
N. Y. State Mus. Mem. 4, p.178, pl.66, fig.15–17. 1900
Clitocybe adirondackensis *Pk.*
N. Y. State Mus. Rep't 54, p.174–75, pl.69, fig.1–13. 1901
Clitocybe amethystina *(Bolt.) Pk.*
N. Y. State Mus. Bul. 116, p.40–41, pl.106, fig.1–6. 1907
Clitocybe clavipes *(Pers.) Fr.*
N. Y. State Mus. Rep't 49, p.58, pl.45. fig.1–7. 1896. Bot. ed.
N. Y. State Mus. Mem. 4, p.139–40, pl.46, fig.1–6. 1900
Clitocybe infundibuliformis *Schaeff.*
N. Y. State Mus. Rep't 48, p.174–75, pl.24, fig.1–6. 1896. Bot. ed.
Clitocybe laccata *Scop.*
N. Y. State Mus. Rep't 48, p.175–77, pl.25. 1896. Bot. ed.
Clitocybe maculosa *Pk.*
N. Y. State Mus. Rep't 54, p.174, pl.69, fig.14–21. 1901

Clitocybe media *Pk.*
N. Y. State Mus. Rep't 48, p.173–74, pl.23, fig.1–7. 1896. Bot. ed.
Clitocybe monadelpha *Morg.*
N. Y. State Mus. Rep't 51, p.302–3, pl.51, fig.1–5. 1898
N. Y. State Mus. Mem. 4, p.140–41, pl.46, fig.7–12. 1900
Clitocybe multiformis *Pk.*
N. Y. State Mus. Mem. 4, p.141, pl.47, fig.1–9. 1900
Clitocybe nebularis *Batsch*
N. Y. State Mus. Rep't 48, p.172–73, pl.23, fig.8–13. 1896. Bot. ed.
Clitocybe ochropurpurea *Berk.*
N. Y. State Mus. Bul. 116, p.41–42, pl.106, fig.7–11. 1907
Clitocybe subcyathiformis *Pk.*
N. Y. State Mus. Bul. 122, p.136–37, pl.110, fig.1–6. 1908
Clitopilus abortivus *B. & C.*
N. Y. State Mus. Bul. 54, p.968–69, pl.78, fig.13–19. 1902
Clitopilus micropus *Pk.*
N. Y. State Mus. Bul. 54, p.970, pl.78, fig.1–12. 1902
Clitopilus orcella *Bull.*
N. Y. State Mus. Rep't 48, p.153, pl.14, fig.7–11. 1896. Bot. ed.
Clitopilus prunulus *Scop.*
N. Y. State Mus. Rep't 48, p.152–53, pl.14, fig.1–6. 1896. Bot. ed.
Collybia acervata *Fr.*
N. Y. State Mus. Bul. 75, p.27–28, pl.84, fig.8–13. 1904
Collybia dryophila *(Bull.) Fr.*
N. Y. State Mus. Bul. 122, p.137–38, pl.111. 1908
Collybia familia *Pk.*
N. Y. State Mus. Bul. 75, p.28–29, pl.84, fig.1–7. 1904
Collybia platyphylla *Fr.*
N. Y. State Mus. Mem. 4, p.142–43, pl. 49. 1900
Collybia radicata *(Relh.) Fr.*
N. Y. State Mus. Rep't 51, p.304–5, pl.52. 1898
N. Y. State Mus. Mem. 4, p.143–44, pl.48. 1900
Collybia velutipes (*Curt.*) *Fr.*
N. Y. State Mus. Rep't 51, p.305–6, pl.50, fig.11–16. 1898
N. Y. State Mus. Mem. 4, p.144–45, pl.47, fig.10–15. 1900
Coprinus atramentarius *Fr.*
N. Y. State Mus. Rep't 48, p.144–45, pl.11, fig.7–11. 1896. Bot. ed.
Coprinus comatus *Fr.*
N. Y. State Mus. Rep't 48, p.143–44, pl.10. 1896. Bot. ed.
Coprinus micaceus *Fr.*
N. Y. State Mus. Rep't 48, p.145–47, pl.11, fig.1–6. 1896. Bot. ed.
Cortinarius cinnamomeus *Fr.*
N. Y. State Mus. Rep't 48, p.149–50, pl.13, fig.7–20. 1896. Bot. ed.
Cortinarius collinitus *Fr*
N. Y. State Mus. Rep't 48, p.149, pl.13, fig.1–6. 1896. Bot. ed.
Cortinarius corrugatus *Pk.*
N. Y. State Mus. Bul. 25, p.674, pl.57, fig.6–13. 1899
N. Y. State Mus. Mem. 4, p.161–62, pl.58, fig.8–15. 1900
Cortinarius evernius *Fr.*
N. Y. State Mus. Mem. 4, p.162–63, pl.58, fig.1–7. 1900

Cortinarius violaceus *Fr.*
N. Y. State Mus. Rep't 48, p.148–49, pl.12. 1896. Bot. ed.
Craterellus cantharellus *(Schw.) Fr.*
N. Y. State Mus. Rep't 49, pl. 44, fig. 1–5. 1896. Bot. ed.
N. Y. State Mus. Mem. 4, p.177–78, pl.56, fig.17–21. 1900
Craterellus cornucopioides *Pers.*
N. Y. State Mus. Rep't 48, p.208–9, pl.24, fig.7–10. 1896. Bot. ed.
Crepidotus malachius *B. & C.*
N. Y. State Mus. Bul. 122, p.139, pl.112, fig.1–4. 1908
Fistulina hepatica *Fr.*
N. Y. State Mus. Rep't 48, p.204–5, pl.37, fig.5–9. 1896. Bot. ed.
Gyromitra esculenta *Fr.*
N. Y. State Mus. Rep't 48, p.128–29, pl.5, fig.1–3. 1896. Bot. ed.
Helvella crispa *Fr.*
N. Y. State Mus. Rep't 48, p.129–30, pl.5, fig.4–7. 1896. Bot. ed.
Hydnum albidum *Pk.*
N. Y. State Mus. Rep't 51, p.310, pl.56, fig.1–7. 1898
N. Y. State Mus. Mem. 4, p.175–76, pl.67, fig.1–7. 1909
Hydnum caput-ursi *Fr.*
N. Y. State Mus. Rep't 51, p.310–12, pl.56, fig.8–12. 1898
N. Y. State Mus. Mem. 4, p.176–77, pl.67, fig.8–12. 1900
Hydnum coralloides *Scop.*
N. Y. State Mus. Rep't 48, p.207–8, pl.24, fig.7–10. 1896. Bot. ed.
Hydnum repandum *L.*
N. Y. State Mus. Rep't 48, p.206–7, pl.38. 1896. Bot. ed.
Hygrophorus cantharellus *Schw.*
N. Y. State Mus. Rep't 54, p.175–76, pl.76, fig.8–20. 1901
Hygrophorus chlorophanus *Fr.*
N. Y. State Mus. Mem. 4, p.147, pl.51, fig.13–20. 1900
Hygrophorus flavodiscus *Frost*
N. Y. State Mus. Rep't 51, p.303–4, pl.51, fig.6–11. 1898
N. Y. State Mus. Mem. 4, p.145, pl.50, fig.1–6. 1900
Hygrophorus fuliginosus *Frost*
N. Y. State Mus. Rep't 49, p.59, pl.45, fig.8–14. 1896. Bot. ed.
N. Y. State Mus. Mem. 4, p.146, pl.50, fig.7–12. 1900
Hygrophorus laricinus *Pk.*
N. Y. State Mus. Mem. 4, p.146–47, pl.51, fig.1–12. 1900
Hygrophorus laurae *Morg.*
N. Y. State Mus. Bul. 54, p.967–68, pl.77, fig.6–14. 1902
Hygrophorus laurae decipiens *Pk.*
N. Y. State Mus. Bul. 94, p.46, pl.88, fig.8–11. 1905
Hygrophorus miniatus *Fr.*
N. Y. State Mus. Rep't 48, p.182–84, pl.28, fig.1–10. 1896. Bot. ed.
Hygrophorus nitidus *B. & C.*
N. Y. State Mus. Bul. 94, p.45, pl.88, fig.1–7. 1905
Hygrophorus pratensis *Fr.*
N. Y. State Mus. Rep't 48, p.181–82, pl.28, fig.11–17. 1896. Bot. ed.
Hygrophorus pudorinus *Fr.*
N. Y. State Mus. Bul. 67, p.41–42, pl.83, fig.1–6. 1903

Hygrophorus puniceus *Fr.*
N. Y. State Mus. Bul. 25, p.675, pl.58, fig.1–7. 1899
N. Y. State Mus. Mem. 4, p.149, pl.52, fig.1–7. 1900
Hygrophorus speciosus *Pk.*
N. Y. State Mus. Mem. 4, p.148, pl.51, fig.21–28. 1900
Hygrophorus virgineus *(Wulf.) Fr.*
N. Y. State Mus. Bul. 25, p.675–76, pl.58, fig.8–12. 1899
N. Y. State Mus. Mem. 4, p.150, pl.52, fig.8–12. 1900
Hypholoma aggregatum sericeum *Pk.*
N. Y. State Mus. Bul. 54, p.972–73, pl.79, fig.8–14. 1902
Hypholoma incertum *Pk.*
N. Y. State Mus. Bul. 25, p.676–77, pl.58, fig.13–20. 1899
N. Y. State Mus. Mem. 4, p.165–66, pl.60, fig.1–9. 1900
Hypholoma perplexum *Pk.*
N. Y. State Mus. Rep't 49, p.61–62, pl.47, fig.11–18. 1896. Bot. ed.
N. Y. State Mus. Mem. 4, p.166–67, pl.60, fig.10–17. 1900
Hypomyces lactifluorum *(Schw.) Tul.*
N. Y. State Mus. Bul. 105, p.43–44, pl.103. 1906
Lactarius chelidonium *Pk.*
N. Y. State Mus. Bul. 25, p.677–78, pl.59, fig.1–6. 1899
N. Y. State Mus. Mem. 4, p. 150–51, pl.53, fig.1–6. 1900
Lactarius deceptivus *Pk.*
N. Y. State Mus. Rep't 54, p.177–78, pl.70, fig.7–11. 1901
Lactarius deliciosus *Fr.*
N. Y. State Mus. Rep't 48, p.185–86, pl.29. 1896. Bot. ed.
Lactarius distans *Pk.*
N. Y. State Mus. Bul. 25, p.678–79, pl.59, fig.7–11. 1899
N. Y. State Mus. Mem. 4, p.151–52, pl.53, fig.7–11. 1900
Lactarius gerardii *Pk.*
N. Y. State Mus. Bul. 25, p.679, pl.59, fig.12–16. 1899
N. Y. State Mus. Mem. 4, p.152–53, pl.53, fig.12–16. 1900
Lactarius luteolus *Pk.*
N. Y. State Mus. Bul. 67, p.43, pl.83, fig.7–11. 1903
Lactarius rimosellus *Pk.*
N. Y. State Mus. Bul. 105, p.37, pl.95, fig.1–6. 1906
Lactarius serifluus (*DC.*) *Fr.*
N. Y. State Mus. Bul. 105, p.37–38, pl.95, fig.7–11. 1906
Lactarius subdulcis (*Bull.*) *Fr.*
N. Y. State Mus. Bul. 67, p.43–45, pl.83, fig.12–24. 1903
Lactarius subpurpureus *Pk.*
N. Y. State Mus. Rep't 54, p.176–77, pl.70, fig.1–6. 1901
Lactarius volemus *Fr.*
N. Y. State Mus. Rep't 48, p.186–88, pl.30. 1896. Bot. ed.
Lepiota americana *Pk.*
N. Y. State Mus. Rep't 49, p.56–57, pl.44, fig.6–10. 1896. Bot. ed.
N. Y. State Mus. Mem. 4, p.136–37, pl.44, fig.11–16. 1900
Lepiota cepaestipes *Sow.*
N. Y. State Mus. Bul. 94, p.44–45, pl.87. 1905
Lepiota clypeolaria (*Bull.*) *Fr.*
N. Y. State Mus. Rep't 54, p.173, pl.76, fig.1–7. 1901

Lepiota naucinoides *Pk.*
N. Y. State Mus. Rep't 48, p.162–64, pl.19. 1896. Bot. ed.
Lepiota procera *Scop.*
N. Y. State Mus. Rep't 48, p.161–62, pl.18. 1896. Bot. ed.
Lycoperdon cyathiforme *Bosc*
N. Y. State Mus. Rep't 48, p.121–22, pl.2. 1896. Bot. ed.
Lycoperdon gemmatum *Batsch*
N. Y. State Mus. Bul. 122, p.135–36, pl.114, fig.7–15. 1908
Lycoperdon giganteum *Batsch*
N. Y. State Mus. Rep't 48, p.121, pl.1. 1896. Bot. ed.
Lycoperdon subincarnatum *Pk.*
N. Y. State Mus. Bul. 122, p.135, pl.114, fig.1–6. 1908
Marasmius oreades *Fr.*
N. Y. State Mus. Rep't 48, p.195–96, pl.33, fig.7–12. 1896. Bot. ed.
Mitrula vitellina irregularis *Pk.*
N. Y. State Mus. Rep't 48, p.130–31, pl.5, fig.8–14. 1896. Bot. ed.
Morchella angusticeps *Pk.*
N. Y. State Mus. Rep't 48, p.125, pl.4, fig.5–9. 1896. Bot. ed.
Morchella bispora *Sor.*
N. Y. State Mus. Rep't 48, p.126–27, pl.3, fig.8–10. 1896. Bot. ed.
Morchella conica *Pers.*
N. Y. State Mus. Rep't 48, p.124–25, pl.4, fig.1–4. 1896. Bot. ed.
Morchella deliciosa *Fr.*
N. Y. State Mus. Rep't 48, p.125–26, pl.3, fig.4–7. 1896. Bot. ed.
Morchella esculenta *Pers.*
N. Y. State Mus. Rep't 48, p.124, pl.3, fig.1–3. 1896. Bot. ed.
Morchella semilibera *DC.*
N. Y. State Mus. Rep't 48, p.126, pl.3, fig.11–13. 1896. Bot. ed.
Paxillus involutus *Fr.*
N. Y. State Mus. Rep't 48, p.150–51, pl.28, fig.18–23. 1896. Bot. ed.
Pholiota adiposa *Fr.*
N. Y. State Mus. Rep't 49, p.60–61, pl.46, fig.18–23. 1896. Bot. ed.
N. Y. State Mus. Mem. 4, p.160–61, pl.57, fig. 12–17. 1900
Pholiota caperata *Pers.*
N. Y. State Mus. Rep't 54, p.182, pl.73, fig.1–5. 1901
Pholiota duroides *Pk.*
N. Y. State Mus. Bul. 131, p.39–40, pl.116, fig.1–7. 1909
Pholiota praecox (*Pers.*) *Fr.*
N. Y. State Mus. Rep't 49, p.59–60, pl.46, fig.1–17. 1896. Bot. ed.
N. Y. State Mus. Mem. 4, p.159–60, pl.57, fig.1–11. 1900
Pholiota squarrosa *Muell.*
N. Y. State Mus. Bul. 54, p.971–72, pl.79, fig.1–7. 1902
Pholiota squarrosoides *Pk.*
N. Y. State Mus. Rep't 54, p.183, pl.73, fig.6–15. 1901
Pholiota vermiflua *Pk.*
N. Y. State Mus. Bul. 75, p.32, pl.86, fig.12–20. 1904
Phylloporus rhodoxanthus (*Schw.*) *Bres.*
N. Y. State Mus. Bul. 131, p.40–41, pl.116, fig.8–11. 1909
Pleurotus ostreatus *Fr.*
N. Y. State Mus. Rep't 48, p.180–81, pl.26, fig.5–9. 1896. Bot. ed.

Pleurotus sapidus *Kalchb.*
N. Y. State Mus. Rep't 48, p.179–80, pl.27. 1896. Bot. ed.
Pleurotus ulmarius *Bull.*
N. Y. State Mus. Rep't 48, p.177–79, pl.26, fig.1–4. 1896. Bot. ed.
Pluteus cervinus (*Schaeff.*) *Fr.*
N. Y. State Mus. Rep't 54, p.181–82, pl.74, fig.9–19. 1901
Polyporus sulphureus *Fr.*
N. Y. State Mus. Rep't 48, p.203–4, pl.37, fig.1–4. 1896. Bot. ed.
Psilocybe foenisecii (*Pers.*) *Fr.*
N. Y. State Mus. Bul. 75, p.33–34, pl.86, fig.1–11. 1904
Russula abietina *Pk.*
N. Y. State Mus. Rep't 54, p.180–81, pl.72, fig.1–11. 1901
Russula albida *Pk.*
N. Y. State Mus. Bul. 105, p.38, pl.96. 1906
Russula brevipes *Pk.*
N. Y. State Mus. Rep't 54, p.178–79, pl.71, fig.1–5. 1901
Russula compacta *Frost*
N. Y. State Mus. Bul. 116, p.42, pl.109. 1907
Russula crustosa *Pk.*
N. Y. State Mus. Bul. 67, p.45–46, pl.84, fig.1–7. 1903
Russula earlei *Pk.*
N. Y. State Mus. Bul. 116, p.42. 1907
N. Y. State Mus. Bul. 67, p.24, pl.N, fig.5–10. 1903
Russula flavida *Frost*
N. Y. State Mus. Bul. 105, p.38–39, pl.97. 1906
Russula furcata (*Pers.*) *Fr.*
N. Y. State Mus. Bul. 75, p.31–32, pl.85, fig.9–14. 1904
Russula mariae *Pk.*
N. Y. State Mus. Bul. 75, p.29–31, pl.85, fig.1–8. 1904
Russula nigricans (*Bull.*) *Fr.*
N. Y. State Mus. Rep't 54, p.178, pl.71, fig.6–9. 1901
Russula ochrophylla *Pk.*
N. Y. State Mus. Rep't 51, p.307–8, pl.53, fig.8–14. 1898
N. Y. State Mus. Mem. 4, p.154–55, pl.54, fig.8–14. 1900
Russula pectinatoides *Pk.*
N. Y. State Mus. Bul. 116, p.43, pl.105, fig.6–10. 1907
Russula pusilla *Pk.*
N. Y. State Mus. Bul. 122, p.138, pl.110, fig.7–14. 1908
Russula roseipes (*Secr.*) *Bres.*
N. Y. State Mus. Rep't 51, p.306–7, pl.53, fig.1–7. 1898
N. Y. State Mus. Mem. 4, p.153–54, pl. 54, fig.1–7. 1900
Russula rugulosa *Pk.*
N. Y. State Mus. Rep't 54, p.179–80, pl.72, fig. 12–18. 1901
Russula sordida *Pk.*
N. Y. State Mus. Bul. 105, p.39–40, pl.98. 1906
Russula subsordida *Pk.*
N. Y. State Mus. Bul. 105, p.40–41, pl.99. 1906
Russula uncialis *Pk.*
N. Y. State Mus. Bul. 116, p.43, pl.107, fig.7–12. 1907

Russula variata *Banning*
N. Y. State Mus. Bul. 105, p.41–42, pl.101. 1906
Russula virescens *Fr.*
N. Y. State Mus. Rep't 48, p.189–90, pl.31. 1896. Bot. ed.
Russula viridella *Pk.*
N. Y. State Mus. Bul. 105, p.41, pl.100. 1906
Strobilomyces strobilaceus (*Scop.*) *Berk.*
N. Y. State Mus. Bul. 94, p.48–49, pl.92. 1905
Stropharia bilamellata *Pk.*
N. Y. State Mus. Bul. 122, p.139–40, pl.112, fig.5–10. 1908
Tricholoma hirtellum *Pk.*
N. Y. State Mus. Bul. 116, p.38–39, pl.105, fig.1–5. 1907
Tricholoma imbricatum *Fr.*
N. Y. State Mus. Rep't 48, p.169–70, pl.21, fig.6–11. 1896. Bot. ed.
Tricholoma nudum (*Bull.*) *Fr.*
N. Y. State Mus. Bull. 116, p.39–40, pl.104. 1907
Tricholoma personatum *Fr.*
N. Y. State Mus. Rep't 48, p.170–72, pl.22. 1896. Bot. ed.
Tricholoma portentosum centrale *Pk.*
N. Y. State Mus. Bul. 25, p.673, pl.57, fig.1–5. 1899
N. Y. State Mus. Mem. 4, p.138–39, pl.45, fig.1–5. 1900
Tricholoma radicatum *Pk.*
N. Y. State Mus. Bul. 67, p.40–41, pl.82, fig.15–19. 1903
Tricholoma russula (*Schaeff.*) *Fr.*
N. Y. State Mus. Bul. 54, p.966–67, pl.77, fig.1–5. 1902
Tricholoma silvaticum *Pk.*
N. Y. State Mus. Bul. 67, p.41, pl.82, fig.1–6. 1903
Tricholoma sordidum (*Schum.*) *Fr.*
N. Y. State Mus. Bul. 131, p.38–39, pl.115. 1909
Tricholoma subacutum *Pk.*
N. Y. State Mus. Bul. 67, p.39–40, pl.82, fig.7–14. 1903
Tricholoma terreum fragrans *Pk.*
N. Y. State Mus. Rep't 49, p.57, pl.47, fig.1–10. 1896. Bot. ed.
N. Y. State Mus. Mem. 4, p.137–38, pl.45, fig.6–15. 1900
Tricholoma transmutans *Pk.*
N. Y. State Mus Rep't 48, p.168–69, pl.21, fig.1–5. 1896. Bot. ed.
Tricholoma unifactum *Pk.*
N. Y. State Mus. Bul. 105, p.36–37, pl.94. 1906

Poisonous or unwholesome

Amanita muscaria *L.*
N. Y. State Mus. Rep't 48, p.212–15, pl.42. 1896. Bot. ed.
Amanita phalloides *Fr.*
N. Y. State Mus. Rep't 48, p.215–17, pl.40, 41, fig.1–3. 1896. Bot. ed.
Amanita verna *Bull.*
N. Y. State Mus. Bul. 48, p.215, pl.41, fig.4–7. 1896. Bot. ed.
Boletus felleus *Bull.*
N. Y. State Mus. Rep't 48, p.217–18, pl.43. 1896. Bot. ed.
Clitocybe illudens *Schw.*
N. Y. State Mus. Rep't 49, p.65, pl.49. 1986. Bot. ed.
N. Y. State Mus. Mem. 4, p.179–80, pl.68. 1900

LIST OF GENERA WHOSE NEW YORK SPECIES (CHIEFLY) HAVE BEEN COLLATED WITH DESCRIPTIONS IN THE STATE BOTANIST'S REPORTS CITED

Aecidium
N. Y. State Mus. Rep't 24, p.105-8. 1872
Agaricus
N. Y. State Cab. Rep't 23, p.96-98. 1872. Bot. ed.
N. Y. State Mus. Rep't 36, p.41-49. 1884
Amanita
N. Y. State Cab. Rep't 23, p.68-70. 1872. Bot. ed.
N. Y. State Mus. Rep't 33, p. 38-49. 1880
Armillaria
N. Y. State Cab. Rep't 23, p.73. 1872. Bot. ed.
N. Y. State Mus. Rep't 43, p.40-44. 1890. Bot. ed.
N. Y. State Mus. Rep't 43, p.44-45. 1890. Bot. ed. (United States species)
Boletus
N. Y. State Cab. Rep't 23, p.127-33 1872. Bot. ed.
N. Y. State Mus. Bul. 2, p.57-66. 1887
N. Y. State Mus. Bul. 8, p.80-157. 1889. (United States species)
Boletinus
N. Y. State Mus. Bul. 8, p.74-80. 1889. (United States species)
Cantharellus
N. Y. State Cab. Rep't 23, p.121-24. 1872. Bot. ed.
N. Y. State Mus. Bul. 2, p.34-43. 1887
Claudopus
N. Y. State Mus. Rep't 39, p.67-69. 1886
Clavaria
N. Y. State Mus. Rep't 24, p.104-5. 1872
Clitocybe
N. Y. State Cab. Rep't 23, p.75-78. 1872. Bot. ed.
Clitopilus
N. Y. State Mus. Rep't 42, p.39-46. 1889. Bot. ed.
Collybia
N. Y. State Cab. Rep't 23, p.78-80. 1872. Bot. ed.
N. Y. State Mus. Rep't 49, p. 32-55. 1896. Bot. ed.
Coprinus
N. Y. State Cab. Rep't 23, p.103-4. 1872. Bot. ed.
Cortinarius
N. Y. State Cab. Rep't 23, p.105-12. 1872. Bot. ed.
Craterellus
N. Y. State Mus. Bul. 2, p.44-48. 1887
Crepidotus
N. Y. State Mus. Rep't 39, p.69-73. 1886
Entoloma
N. Y. State Cab. Rep't 23, p.88. 1872. Bot. ed.
N. Y. State Mus. Bul. 131, p.47-54. 1909

Flammula
N. Y. State Cab. Rep't 23, p.90–91. 1872. Bot. ed.
N. Y. State Mus. Rep't 50, p.133–44. 1897
Galera
N. Y. State Cab. Rep't 23, p.93–94. 1872. Bot. ed.
N. Y. State Mus. Rep't 46, p.61–69. 1893. Bot. ed.
Hebeloma
N. Y. State Cab. Rep't 23, p.95–96. 1872. Bot. ed.
Helvella
N. Y. State Mus. Rep't, 31, p.60. 1879
Hygrophorus
N. Y. State Cab. Rep't 23, p.112–14. 1872. Bot. ed.
N. Y. State Mus. Bul. 116, p.45–67. 1907
Hypholoma
N. Y. State Cab. Rep't 23, p.98–99. 1872. Bot. ed.
Lactarius
N. Y. State Cab. Rep't 23, p.114–20. 1872. Bot. ed.
N. Y. State Mus. Rep't 38, p.111–33. 1885
Lentinus
N. Y. State Cab. Rep't 23, p.126–27. 1872. Bot. ed.
N. Y. State Mus. Bul. 131, p.42–47. 1909
Lepiota
N. Y. State Cab. Rep't 23, p.70–73. 1872. Bot. ed.
N. Y. State Mus. Rep't 35, p.150–64. 1884
Leptonia
N. Y. State Cab. Rep't 23, p.89. 1872. Bot. ed.
Lycoperdon
N. Y. State Mus. Rep't 32, p.58–72. 1879
Marasmius
N. Y. State Cab. Rep't 23, p.124–26. 1872. Bot. ed.
Mycena
N. Y. State Cab. Rep't 23, p.80–84. 1872. Bot. ed.
Naucoria
N. Y. State Cab. Rep't 23, p.91–93. 1872. Bot. ed.
Odontia
N. Y. State Mus. Rep't 53, p.847. 1900
Omphalia
N. Y. State Cab. Rep't 23, p.84–85. 1872. Bot. ed.
N. Y. State Mus. Rep't 45, p.32–42. 1893. Bot. ed.
Panaeolus
N. Y. State Cab. Rep't 23, p.100–2. 1872. Bot. ed.
Paxillus
N. Y. State Mus. Bul. 2, p.29–33. 1887
Pholiota
N. Y. State Cab. Rep't 23, p.89–90. 1872. Bot. ed.
N. Y. State Mus. Bul. 122, p.141–58. 1908
Pleurotus
N. Y. State Cab. Rep't 23, p.85–87. 1872. Bot. ed.
N. Y. State Mus. Rep't 39, p.58–67. 1886

Pluteolus

N. Y. State Mus. Rep't 46, p.58–61. 1893. Bot. ed.

Pluteus

N. Y. State Cab. Rep't 23, p.87–88. 1872. Bot. ed.

N. Y. State Mus. Rep't 38, p.133–38. 1885

Psathyrella

N. Y. State Cab. Rep't 23, p.102–3. 1872. Bot. ed.

Psilocybe

N. Y. State Cab. Rep't 23, p.99–100. 1872. Bot. ed.

Puccinia

N. Y. State Mus. Rep't 25, p.110–23. 1873

Russula

N. Y. State Cab. Rep't 23, p.120–21. 1872. Bot. ed.

N. Y. State Mus. Bul. 116, p.67–98. 1907

Spathularia

N. Y. State Mus. Rep't 50, p.118–19. 1897

Strobilomyces

N. Y. State Mus. Bul. 8, p.158–59. 1889. (United States species)

Trametes

N. Y. State Mus. Rep't 54, p.169–70. 1901

Tricholoma

N. Y. State Cab. Rep't 23, p.73–75. 1872. Bot. ed.

N. Y. State Mus. Rep't 44, p.38–64. 1891. Bot. ed.

Xylaria

N. Y. State Mus. Rep't 31, p.59. 1879

EXPLANATION OF PLATES

PLATE II

Hypholoma boughtoni Pk.

BOUGHTON HYPHOLOMA

1 Cluster of three immature plants
2 Mature umbonate plant
3 Mature plant without an umbo
4 Vertical section of upper part of an immature plant
5 Vertical section of upper part of a mature plant
6 Transverse section of a stem
7 Four spores, x 400

HYPHOLOMA BOUGHTONI Pk.
BOUGHTON HYPHOLOMA

PLATE III

Hypholoma rigidipes Pk.

RIGID STEM HYPHOLOMA

1 Immature plant
2 Mature plant
3 Vertical section of upper part of an immature plant
4 Vertical section of upper part of a mature plant
5 Transverse section of a stem
6 Four spores, x 400

Psilocybe nigrella Pk.

BLACKISH PSILOCYBE

7 Immature plant with moist cap
8 Mature plant with moist cap
9 Mature plant with dry cap
10 Vertical section of upper part of a mature plant
11 Four spores, x 400

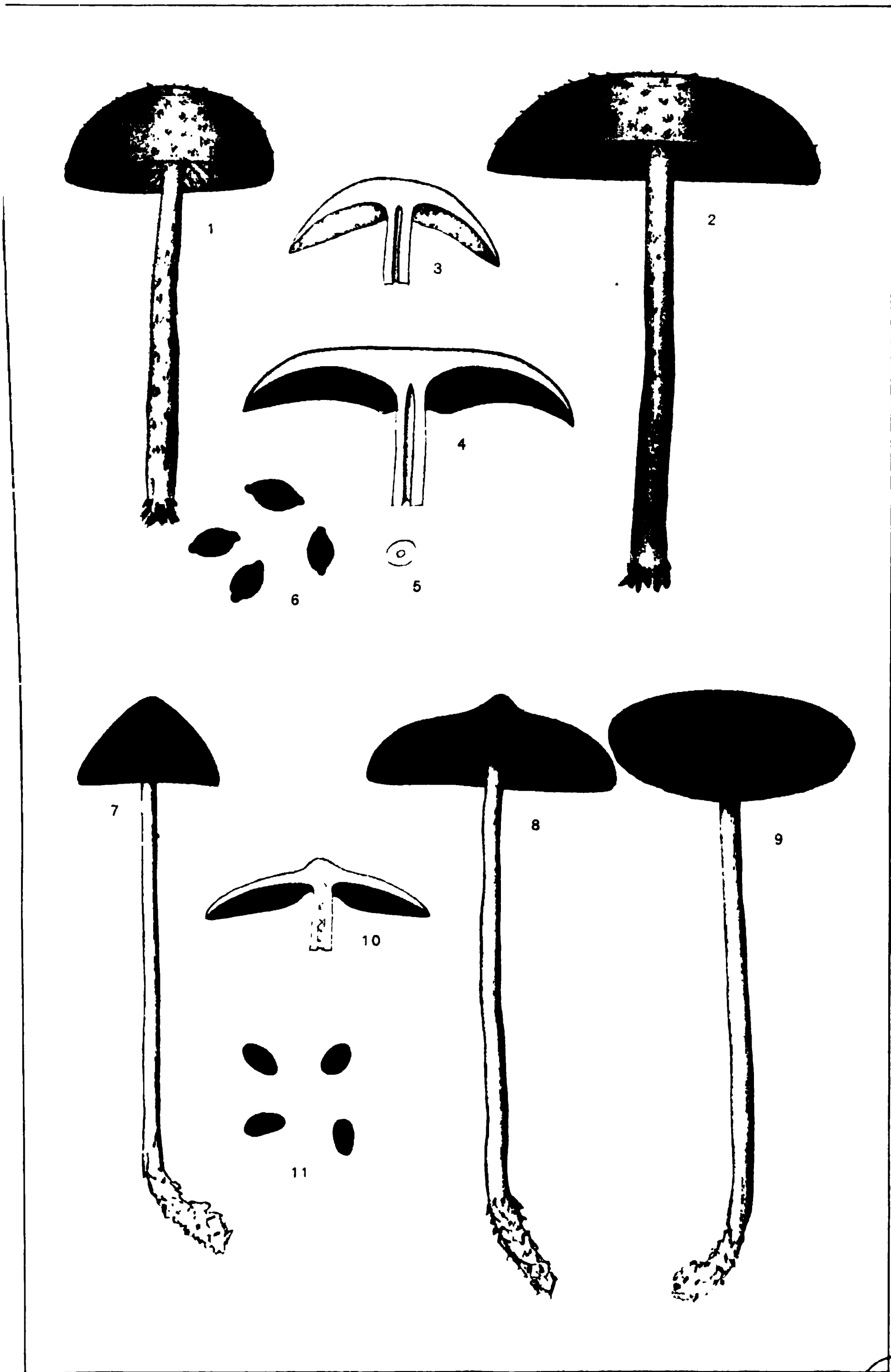


FIG. 1-6
HYPHOLOMA RIGIDIPES PK.
RIGID STEM HYPHOLOMA

FIG. 7-11
PSILOCYBE NIGRELLA PK.
BLACKISH PSILOCYBE

PLATE 117

Hebeloma album Pk.

WHITE HEBELOMA

1 Young plant
2 Mature plant with expanded cap
3 Mature plant with convex cap tinged with yellow
4 Vertical section of upper part of a young plant
5 Vertical section of upper part of a mature plant
6 Four spores, x 400

Clitocybe multiceps Pk.

MANY CAP CLITOCYBE

7 Cluster of seven plants
8 Vertical section of upper part of a plant
9 Four spores, x 400

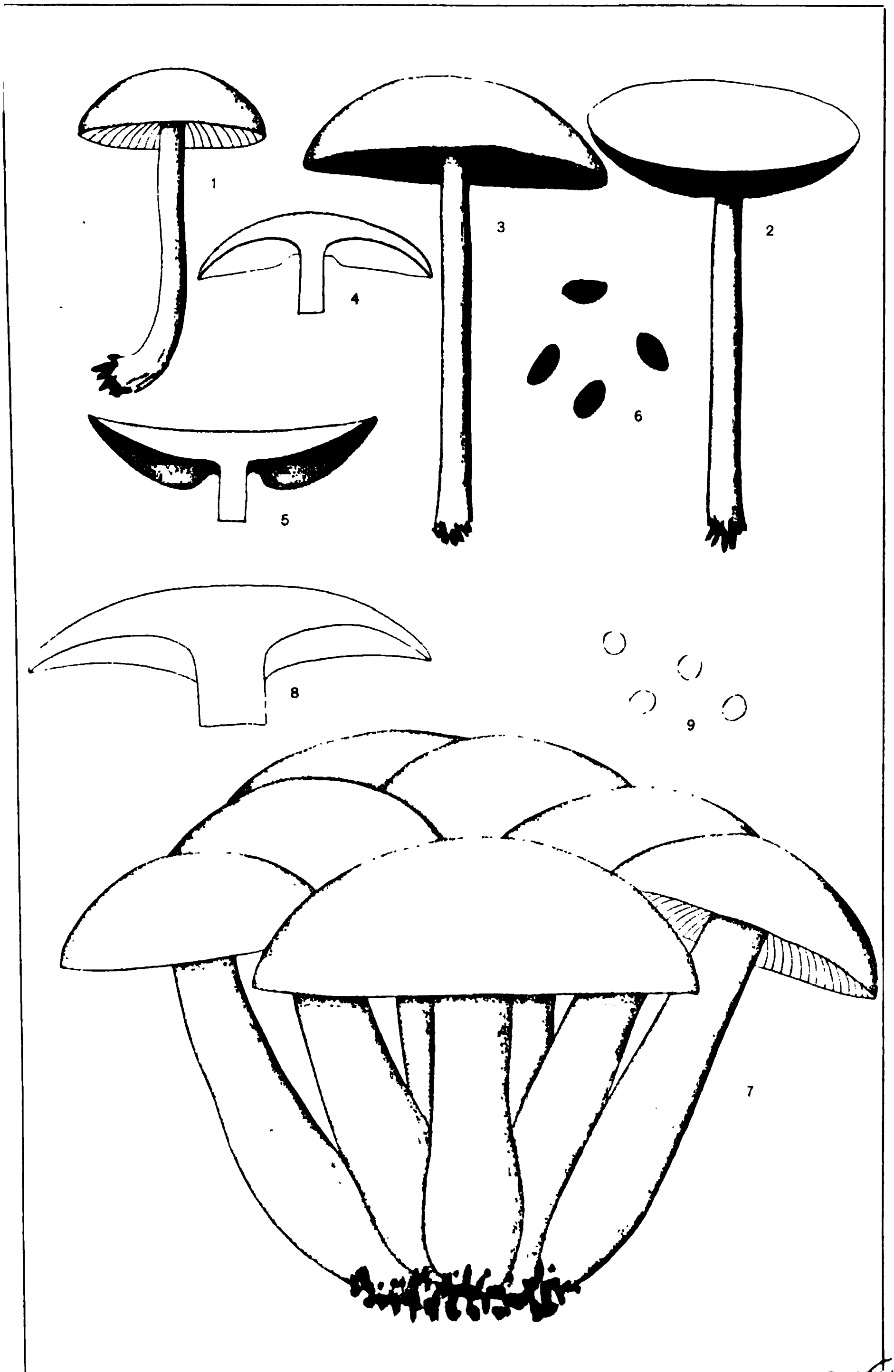


FIG. 1-6
HEBELOMA ALBUM PK.
WHITE HEBELOMA

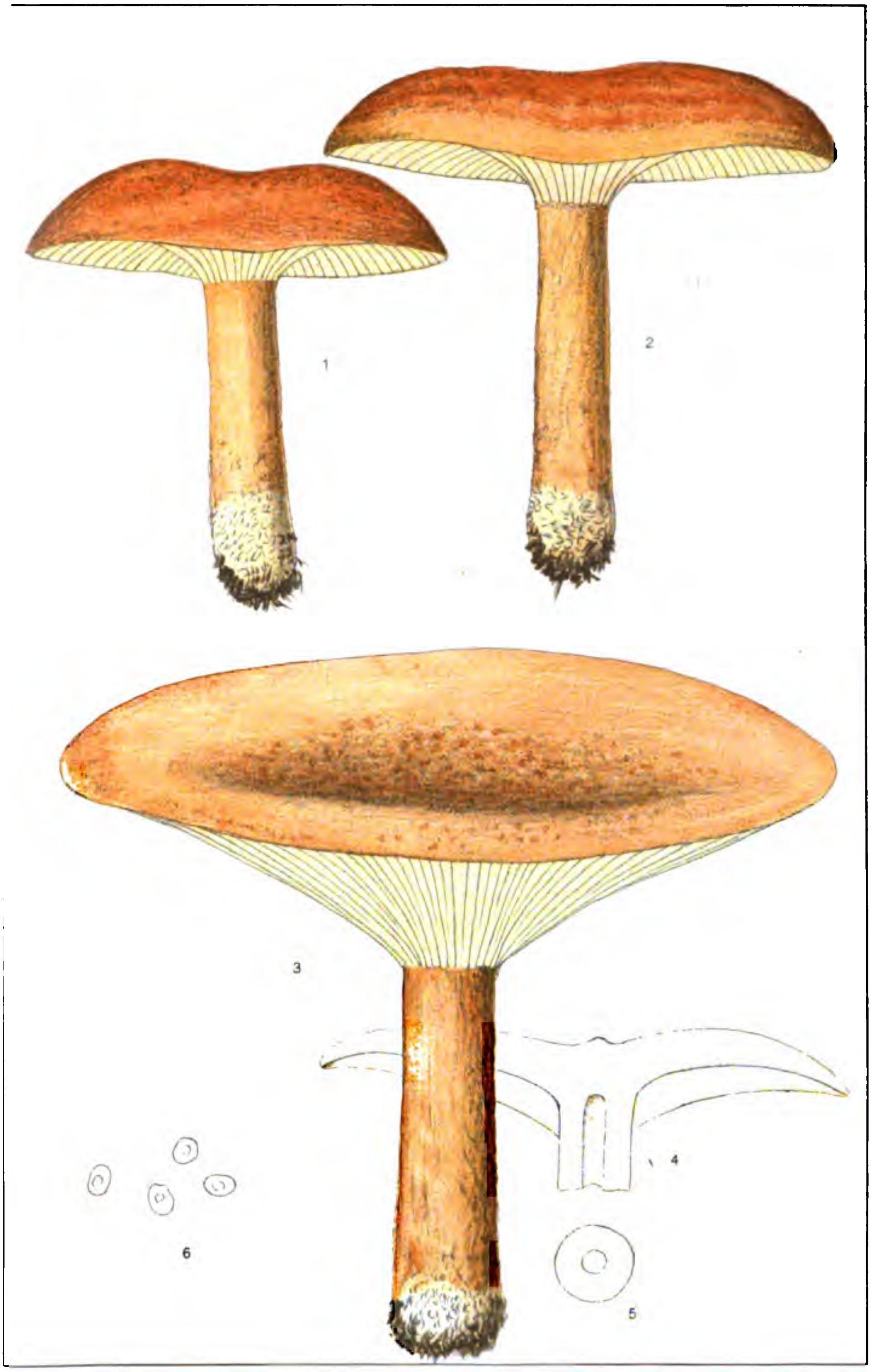
FIG. 7-9
CLITOCYBE MULTICEPS PK.
MANY CAP CLITOCYBE

PLATE 118

Lactarius aquifluus Pk.

WATERY MILK LACTARIUS

1 Young plant with moist cap
2 Mature plant with dry margin
3 Mature plant with entire cap dry
4 Vertical section of upper part of a plant
5 Transverse section of a stem
6 Four spores, x 400



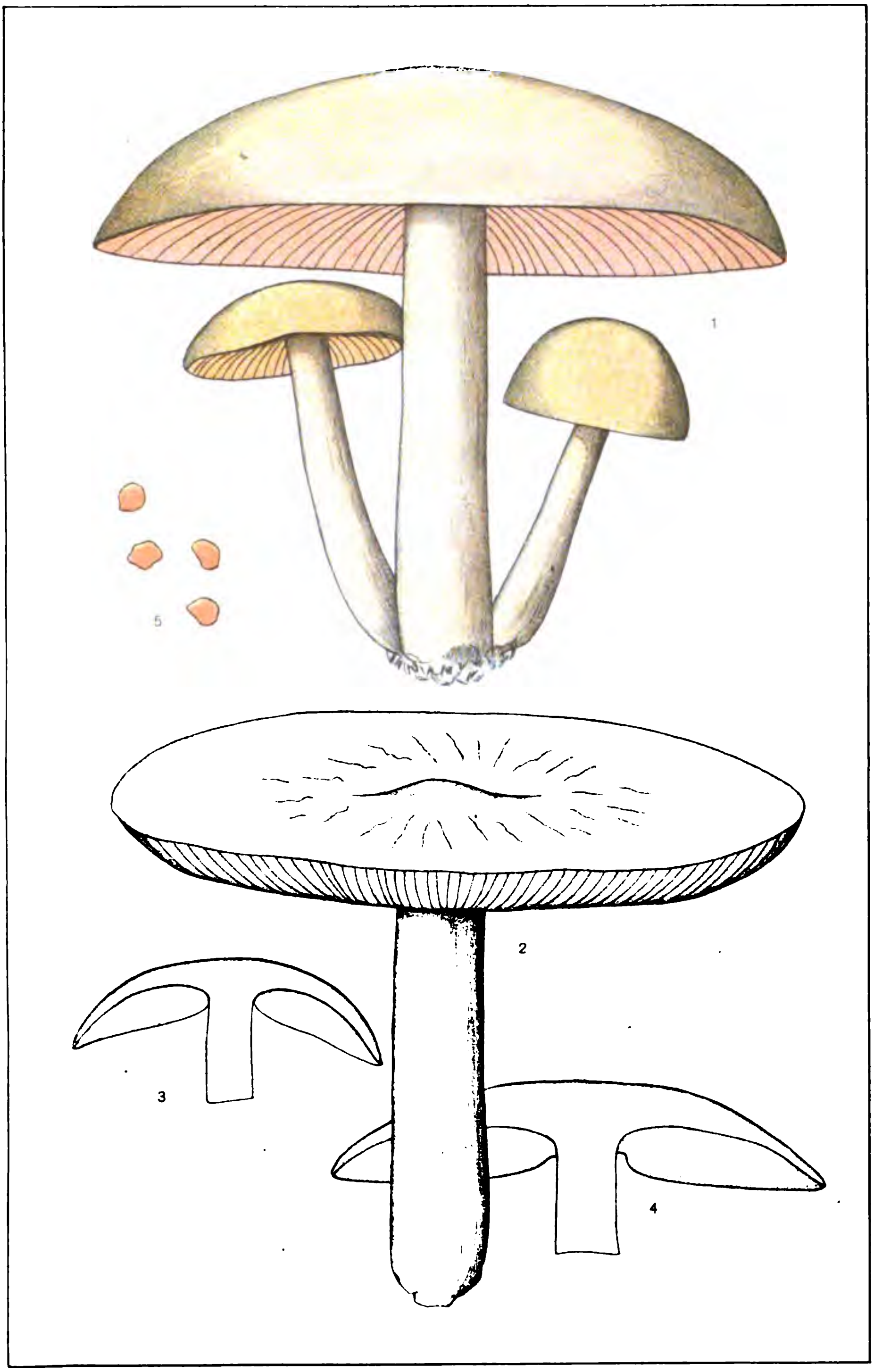
LACTARIUS AQUIFLUUS Pk.
WATERY MILK LACTARIUS

PLATE 119

Entoloma grande Pk.

GRAND ENTOLOMA

1 Cluster of one mature and two young plants
2 Mature plant with umbonate and rugosely wrinkled cap
3 Vertical section of upper part of a young plant
4 Vertical section of upper part of a mature plant
5 Four spores, x 400



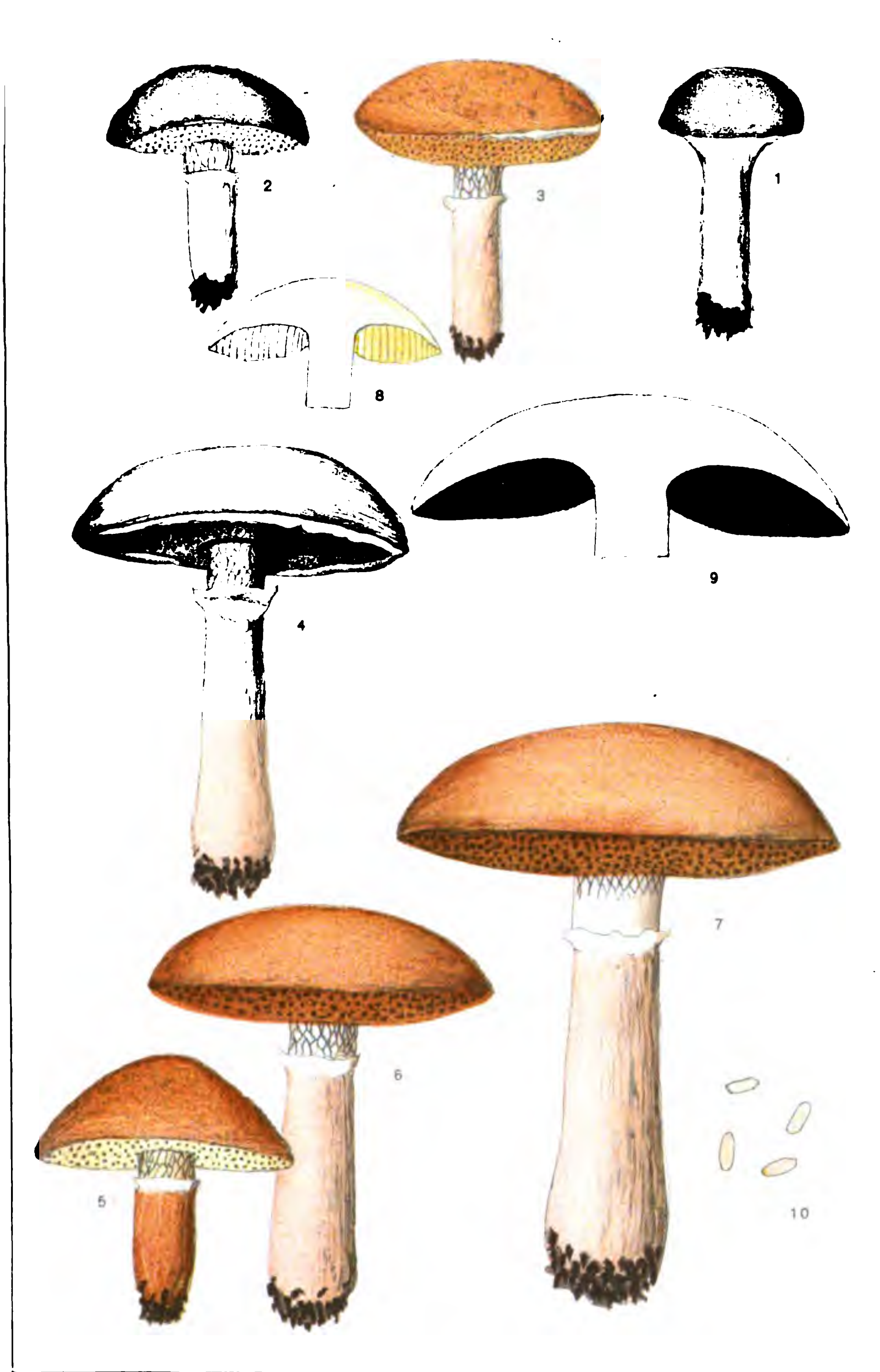
ENTOLOMA GRANDE Pk.
GRAND ENTOLOMA

PLATE 120

Boletus viridarius Frost

GREEN LAWN BOLETUS

1 Young plant with tubes concealed by the veil
2 Young plant with tubes exposed
3 Mature plant showing a fragment of the white veil still adhering to the margin of the cap
4 Mature plant with whitish cap appendiculate with the ruptured veil
5 Young plant with yellowish tubes
6, 7 Mature plants showing color of mature tubes; stem of no. 7 only partly reticulated above the collar
8 Vertical section of upper part of a young plant
9 Vertical section of upper part of a mature plant
10 Four spores, x 400



BOLETUS VIRIDARIUS Frost
GREEN LAWN BOLETUS

EXTRALIMITAL SPECIES

PLATE W

Amanita morrisii Pk.

MORRIS AMANITA

1 Young plant with expanded cap
2 Mature plant with expanded cap and two fragments of the volva adhering to the base of the stem
3 Vertical section of the upper part of a mature plant
4 Four spores, x 400

AMANITA MORRISII Pk.
MORRIS AMANITA

PLATE X

Lactarius bryophilus Pk.

MOSS LOVING LACTARIUS

1 Young plant
2 Mature plant showing upper surface of cap
3 Vertical section of a young plant
4 Vertical section of a mature plant
5 Four spores, x 400

Agaricus eludens Pk.

ELUSIVE MUSHROOM

6 Young plant showing white gills and brown cap
7 Middle aged plant showing pink gills and brown cap
8 Mature plant showing brown gills and scaly cap
9 Mature plant showing red wound spot on the stem
10 Vertical section of upper part of a middle aged plant
11 Vertical section of upper part of a mature plant
12 Transverse section of a stem
13 Four spores, x 400

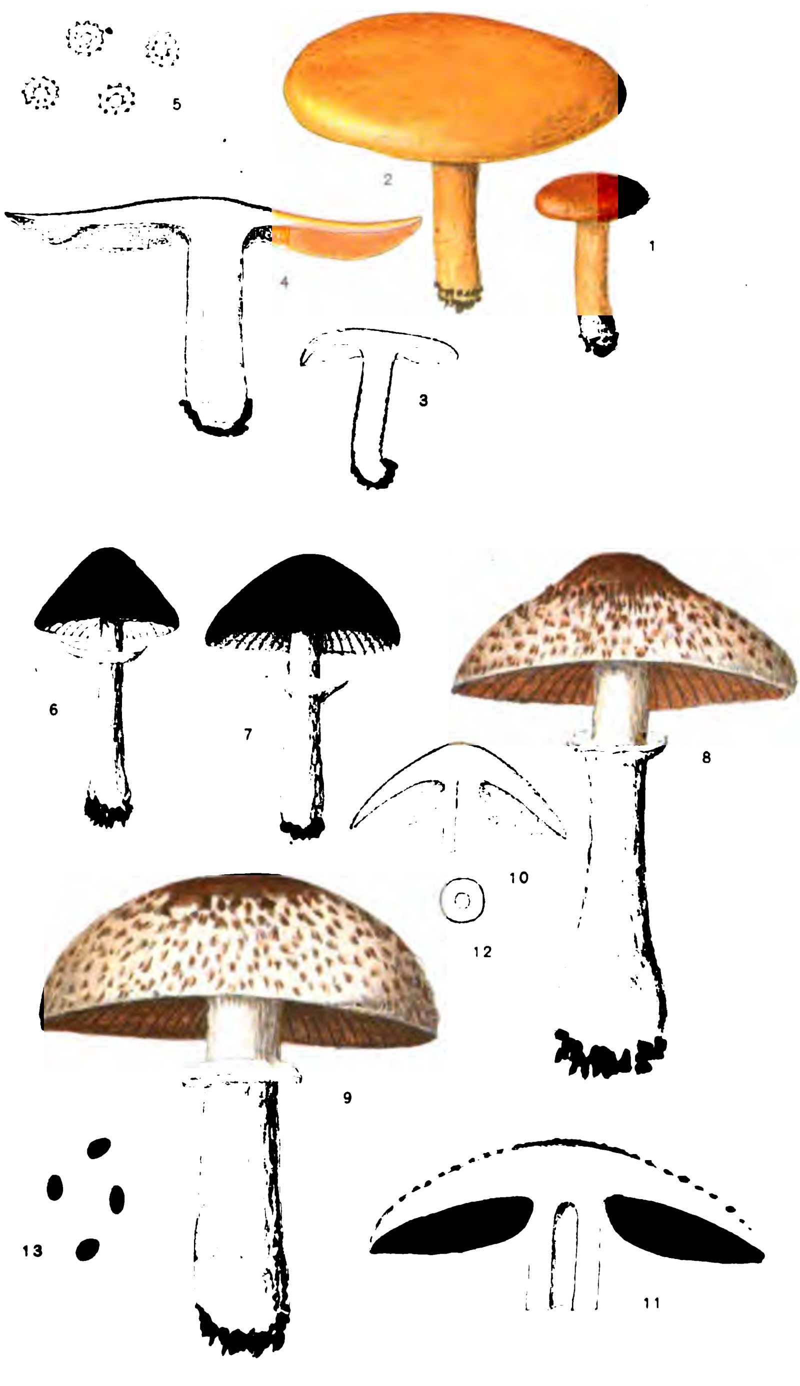


FIG. 1-5
LACTARIUS BRYOPHILUS PK.
MOSS LOVING LACTARIUS

FIG. 6-13
AGARICUS ELUDENS PK.
ELUDING AGARICUS

PLATE Y

Cortinarius ferrugineo-griseus Pk.

RUSTY GRAY CORTINARIUS

1 Young moist plant showing the webby veil
2 Mature moist plant showing remains of the spore stained veil on the stem
3 Vertical section of a young plant
4 Vertical section of a mature plant with part of the cap wanting

G. E. M. del.

CORTINARIUS FERRUGINEO-GRISEUS Pk.
RUSTY GRAY CORTINARIUS

PLATE Z

Cortinarius ferrugineo-griseus Pk.

RUSTY GRAY CORTINARIUS

1 Mature dry plant with violaceous stem
2 Vertical section of a small mature plant with violaceous stem
3 Four spores, x 400

Cortinarius actutoides Pk.

ACUTOID CORTINARIUS

4 Group of six young moist plants, one showing floccose scales of the white veil on the cap
5 Two mature dry plants
6 Vertical section of a young plant
7 Vertical section of a mature plant
8 Four spores, x 400

Russula blackfordae Pk.

BLACKFORD RUSSULA

9, 10 Two plants with convex cap
11 Mature plant with expanded cap
12 Vertical section of a mature plant
13 Four spores, x 400

FIG. 1-3
CORTINARIUS FERRUGINEO-GRISEUS PK.
RUSTY GRAY CORTINARIUS

FIG. 4-8
CORTINARIUS ACUTOIDES PK.
ACUTOID CORTINARIUS

FIG. 9-13
RUSSULA BLACKFORDAE PK.

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